Educ.

The American Biology Teacher

MAY, 1961 VOL. 23, NO. 5

TABLE OF CONTENTS

THE AMERICAN BIOLOGY TEACHER

Publication of the National Association of Biology Teachers.

Issued monthly during the school year from October to May. Second class postage paid at Danville, Illinois.

Publication Office—Interstate Press, 19 N. Jackson St., Danville, Ill.

Editor—PAUL KLINGE, Coordinator for School Science, Indiana University, Bloomington, Indiana.

The Indiana University address will be the official editorial office.

Managing Editor—MURIEL BEUSCHLEIN, 6431 S. Richmond, Chicago 29, Ill.

Subscriptions, renewals, and notices of change of address should be sent to the Secretary-Treasurer, HERMAN KRANZER, Department of Education, Temple University, Philadelphia 22, Pennsylvania. Correspondence concerning advertising should be sent to the Managing Editor.

Annual membership, including subscription, $6.00; subscription to Journal, $6.00; individual copies $.75; outside United States, $6.75; student membership, $3.00.

MEMBERSHIP APPLICATION

NATIONAL ASSOCIATION OF BIOLOGY TEACHERS

Name ______________________
(PLEASE PRINT)

Address ______________________

____

Dues: $6.00 a year, including subscription to

THE AMERICAN BIOLOGY TEACHER

Published monthly, October through May (8 issues)

THE AIBS BULLETIN

For one year (5 issues)

Send application to:

Herman Kranzer, Secretary-Treasurer
Department of Education,
Temple University,
Philadelphia 22, Pennsylvania

Biological Problems in Arctic America*

WILLIAM CAMPBELL STEERE, *Director, The New York Botanical Garden, New York 58*

The topic, "Biological Problems in Arctic America," is timely today because of the recent admission of Alaska to the Union as the 49th State, because of the large amount of publicity given to the activities of the International Geophysical Year in arctic and antarctic regions, and because of the increasing importance of our northern outposts in the military defense of this continent. After eight field seasons in arctic and subarctic Canada, Alaska, and Lapland, I have developed some ideas and some questions that may well be of interest to a group of my biological colleagues.

World War II brought about the sudden accessibility of the arctic, and, as a result, more biologists have visited arctic America in the last fifteen years than in all previous history put together. The reasons for this increased accessibility and the concomitant invasion of the arctic by biologists are several and diverse. Among them are the development of easier and faster methods of transportation, as bush planes on floats, wheels or skis, and tracked vehicles such as weasels and snomobiles instead of dog-sleds; the establishment of new bases for radar sites, weather observation, oil exploration, and other purposes that may be used as research centers; the availability of research grants adequate for arctic exploration as well as other types of field support; and, not necessarily least, the development of repellents effective against the hordes of unbelievably voracious mosquitoes and other biting insects.

My admiration for early botanists, geologists, zoologists, and other scientists in arctic regions knows no bounds. The painful rigors of travel described by Linnaeus for his 1732 journey to arctic Lapland were no greater than those endured by biologists in Greenland and in northern Canada and Alaska up to two decades ago, assailed as they were by difficulties of travel, uncertainty of food supply, and plagues of insects.

Today, thanks to the availability of excellent logistic support and adequate transportation facilities, the danger level has been reduced to indigestion from eating too much of one's own cooking. The chances of falling from a cliff, crashing in a bush plane, starvation—or even vitamin deficiency—or being charged by an enraged bear or muskox are more than equally matched by the perils of slipping in the bathtub at home or being run over while crossing the street.

Arctic Europe has become especially accessible for scientific work. The railroad across Lapland, built in 1903 to carry the rich ores from the great iron mines at Kiruna, at nearly 68° North Latitude, runs west to the Norwegian city of Narvik and east to the Baltic port of Lulea, with most of its length north of the Arctic Circle. Crossing the Arctic Circle while sitting in a comfortable train drinking beer seemed almost ridiculously easy to me, after several field seasons in arctic Canada and Alaska. The contrast is enhanced by the comfortable tourist hotels one finds on the south shore of Lake Torneträsk and the ease with which one may go from one station to another in interesting areas on trains that run with the frequency of suburban commuters. On the North American continent no highways or railroads yet cross the Arctic Circle, but many regularly scheduled airline flights do, and one also may easily charter a flight to any area off the regular airways where landing is possible. Tourist hotels of sorts are available at Kotzebue, Barrow, and elsewhere north of the Arctic Circle.

The two physical characteristics of the American Arctic that most influence the distribution and behavior of plants and animals are the perenially frozen ground and the long days during the growing season. The long winters and brief summers in themselves produce an effect that differs only in degree from that found in more temperate climates.

*Adapted in large part from the address of the retiring President of the Botanical Society of America, delivered at the annual banquet at Oklahoma State University, Stillwater, August 31, 1960, and published in PLANT SCIENCE BULLETIN (October, 1960). Presented in this form at the Annual Banquet, NABT, at the AAAS meetings in New York, December, 1960.

Figure 1. Mrs. Steere and a weasel—a light weight track vehicle that makes tundra travel feasible.

Perennially frozen ground, whether wet or dry, soil or rock, was termed "permafrost" by Simeon Muller in 1943, in his review of the extensive Russian studies of frozen ground in Siberia. Although long accepted as a fact of life in northern Canada and Alsaka, permafrost became a critical factor to engineers engaged in the construction of air-strips and military bases during World War II and, as a consequence, its study has progressed rapidly, with contributions to the solution of geological and biological problems as well as engineering ones. One botanist, William S. Benninghoff, has become a leading expert on permafrost. The term permafrost has been objected to on facetious grounds by some, and seriously by others, although because it is simple and obvious it will continue to be widely used. Professor Kirk Bryan has proposed to replace permafrost with "cryopedology," as the science of frozen ground, with a whole family of subordinate terms such as "cryoplanation," "congeliturbation," "pergelation," "congelifraction," etc., for specific situations. These terms appear more and more frequently in technical papers.

In its northernmost range, permafrost may be extremely thick. It has been reported to extend 2,000 feet downwards in Siberia and is well over 1,000 feet thick in northernmost Alaska. At its southern boundary it becomes very thin and discontinuous and eventually disappears. The origin of present-day permafrost dates from the beginning or from some later phase of the Pleistocene Ice Age, so that it may be as much as a million years old. Pleistocene-Age mammoths frozen into the permafrost have been found so abundantly in Siberia that they furnished for many years the largest single source of commercial ivory.

Permafrost develops where and when the annual mean temperature is from very slightly to very considerably below freezing. It is also influenced by plant cover which may furnish insulation and thereby retard thawing, by serving as a differential heat regulator. Conversely, the removal of the vegetation mat may upset the thermal regime and hasten thawing.

Permafrost must be discussed here because of its all-pervasive effects on the growth of arctic plants and animals and its many correlations with arctic vegetation and the fauna it supports.

1. The maximum depth of superficial thaw each year, the so-called active layer, effectively limits or determines the plants that may grow there. If the active layer is as thin or shallow as 3 inches it will support only sedges, grasses, and other fibrous rooted plants without taproots. Mosses, of course, with no roots, flourish in abundance. Pine is ruled out in permafrost areas because of its deep taproot, whereas black spruce and larch do very well and extend considerably north of the Arctic Circle, where their limit is determined by climate and not by permafrost. Burrowing animals, as well as those living in the soil, are likewise limited in their activities by the depth of thaw.

2. Permafrost provides a base impervious to drainage. Combined with the low evapora-

Figure 2. Frozen ground along the Kuskokwim River near McGrath, Alaska. Floodwaters have melted away the permafrost from under the thin rug-like mat of moss and roots to which all surface life of plants and animals is restricted.

tion rate, water tends to accumulate in spite of the extremely low precipitation. In flat areas, more than half the land surface may be covered with lakes and ponds, and moderate slopes may become water-logged through moss cover that obstructs drainage. One may be tempted to call this area the wettest desert in the world.

3. The permafrost surface beneath the active layer provides a lubricated base for down-hill movements of water-logged soil so that even very gentle slopes tend to be unstable and in motion, sometimes with a very disrupting effect on the vegetation.

4. Frost action in most arctic areas keeps soil, gravel, and rock fragment in continual local movement, even when not sliding gradually downhill. This boiling, churning action, called congeliturbation, destroys the normal chronological stratification that we expect to find in soils. The pressure of freezing water causes the extrusion of materials from lower layers, much as frozen milk is extruded from a bottle. Soil mounds are produced thereby, commonly a few feet high, but more rarely, under the influence of hydrostatic pressure, the mound may become a small hill or "pingo" 20 feet or more high.

5. The boiling and churning of the ground has a second effect—the particles and materials of stony soils are sorted in circles or polygons on flat ground and in "stripes" and rock-streams on mountain sides. The smaller particles move inwards and the larger materials outwards. In wet soils the polygons are separated by vertical ice-wedges that exert greater and greater pressures on the enclosed soil as they grow in depth and thickness. The

Figure 3. Field work is greatly facilitated in the Arctic today by float planes and other modern methods of transportation.

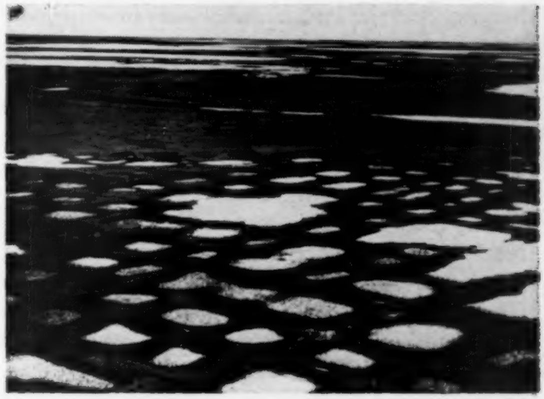


Figure 4. "Patterned ground" in the tundra near Point Barrow. The polygons are formed by the growth of vertical ice wedges between them and are highly typical of permafrost or perennially frozen ground.

development of polygons produces a strong and conspicuous effect on the vegetation. The "patterned ground" produced by frost action is the most conspicuous single feature of arctic areas.

6. In a general way, permafrost has many other effects. If the superficial insulative layer of vegetation is removed, the underlying permafrost will melt, as engineers learned to their sorrow in early experience with air-strips in Alaska. Where the vegetation had been bulldozed off and heat absorption exaggerated by the construction of black asphalt runways, the surface curved and buckled in waves. Relict ice blocks in the soil at the margin of the permafrost area can be a nuisance or even a hazard to agriculture when they melt, as has been seen at Fairbanks, where large caverns have developed underground. Unfortunately, no plant indicator has been discovered for deep-lying permafrost, although some quantitative effect may eventually turn up with more intensive local study.

The construction of buildings on permafrost brings many engineering problems. Buildings even on pilings may transmit heat into the permafrost through the pilings, with a consequent gradual settling as can be seen, for example, at the post office in Nome. Inhabitants of houses with insufficiently insulated floors may be surprised when suddenly the stove drops into a deep pool of mud. I have seen photographs of settlers' cabins in Siberia where downward melting reached an aquafer or water stratum under pressure which

then flooded the house and almost immediately froze.

The physiology of plants and animals growing under permafrost conditions has not been fully investigated and is not well known in this country. Some work has been done on plants growing and even flowering under snow, where temperatures may be above freezing, and where little movement of air occurs. However, plants up to the size of trees that grow with their roots almost upon permanently frozen ground and their tops in air whose temperature is well above freezing would seem to be in a state of perpetual crisis. The late Professor George Peirce of Stanford University once told me, with his usual humor, that is was obviously quite impossible for plants to do this. Since plants *do*, however, *how* they do it certainly needs careful study. Whether the physical chemistry of the roots and root-hairs of arctic plants differs in some way or to some degree from that of plants in temperate climates still remains to be determined. The limitation of all the subterranean activities of plants and animals to the several inches of soil that thaws for a few weeks in the summer presents a situation far different from the one most of us consider to be normal, especially in the deep soils of the prairie states.

Long days during the growing season especially characterize the Arctic—in fact, the Arctic Circle is demarcated by that latitude at which the sun does not set on one night of each year. The higher the latitude, the more "nights" of sunshine, and even though the sun may set in subarctic areas, the nights are nevertheless light enough to support the growth of plants. The continuous light is the phenomenon first noted by the new visitor to arctic areas and is the condition most difficult to imagine until experienced. When one wakes up at 1:30 in the morning with the sun shining in his eyes, it is difficult to convince his physiological control system that day has *not* arrived and to relax and go back to sleep. The occupational hazard experienced by vigorous people in the Arctic is insufficient sleep and overwork. Like people, plants and animals certainly must respond differently in nature to continuous light than they do to the diurnal light rhythms of lower latitudes; yet little experimental work has been done in the arctic with the organisms that grow there. Obviously, on the pragmatic evidence that arctic plants produce flowers and seeds, they are long-day plants—or else "day neutral." Short-day plants that may have existed under earlier and more temperate climates at the same latitudes have undoubtedly disappeared through inability to reproduce. The high incidence of apomixis, bulbilformation, and other devices for vegetative propagation may reflect some adaptation to continuous light, and the long-day requirements imposed thereby. The very common comparison of plants of high altitudes with those of high latitudes, and the lumping of both categories as arctic-alpine plants, tends to underemphasize or to conceal the great difference in day-length conditions which in turn must be reflected by real differences in the physiology of the plants themselves. Although it was long taken for granted that lemmings, voles, and ground squirrels hibernated for several months in a deep stupor during the arctic winter, recent research sponsored by the Arctic Research Laboratory shows that these animals are surprisingly active in winter.

Just as the Arctic Circle is circumscribed by that latitude at which the sun does not go below the horizon one night each year, so it also coincides with the latitude at which the sun does not rise above the horizon one day of the year. At higher latitudes, many days have only twilight, and many others are short, indeed, exactly compensating in length for the opposite seasons. I should mention here the too-common misconception that the arctic is the land of "six months of light and six months of darkness." I have heard serious scientists invoke Wegener's hypothesis of the wandering of the earth's poles, not because of the good reasons given by Wegener, but because they cannot honestly believe that the luxuriant forests, represented now only by abundant fossils, that once reached the farthest northern lands, could have developed under six months of darkness. The presence of coal and abundant plant fossils in Antarctica raises the same question in a more aggravated form. Actually, of course, the darkness, twilight, and very short intervals of light would come during the dormant winter period when photosynthesis is suspended because of low temperatures. The present limit of trees northward on the various continents is determined by temperature and perhaps by other climatic

factors, not by the shortness of day in winter. Forests of one type or another extend well north of the Arctic Circle in Scandinavia, in Siberia, and in North America. Both black spruce (*Picea mariana*) and larch (*Larix laricina*) reach the Arctic Ocean at the mouth of the Mackenzie River in northern Canada, but the tree-line abruptly retreats southward toward Hudson Bay and the Ungava Peninsula, paralleling very neatly the depressed isotherms of the midcontinent. In short, one does not have to invoke the wandering of the earth's poles, whether they wandered or not, to explain the presence of forests in polar areas in earlier geological eras, but only a somewhat warmer and more uniform climate.

With this background, I am sure that every biologist, regardless of his field, can see some problem related to his own interests, but transposed into a different context of environmental conditions. Even if time and space permitted, it would be impossible to discuss or even to list all the important and exciting biological investigations called for in arctic regions. I shall therefore mention a few general problems, only as illustrative examples, to point up the different dimensions and different parameters of biological research in the Arctic.

Although we are well acquainted with the reduced activity of microorganisms at lowered temperatures in the laboratory—and in the home refrigerator—we rarely see its effects in nature. At Barrow and in other arctic seaside villages, the Eskimos abandon everywhere the unused remains of seals, walrus, whales, etc., that they have killed during the spring, adding much thereby to the picturesqueness of their habitat. However, instead of the galloping and richly odoriferous putrefaction inevitable in a warmer climate, decomposition takes place slowly under the low temperature, producing only a somewhat rancid but not wholly repulsive odor to which one's nose eventually adjusts. Beyond this, much remains to be known about the microorganisms of the soil, the water, and the air in arctic regions, with especial reference to their metabolic activities.

The fungi of arctic America have received very little attention from professional mycologists. Since agriculture is relatively unimportant in arctic regions, no economic incentive has precipitated a comprehensive survey of even the parasitic fungi.

Large marine algae are less conspicuous in arctic seas than in even slightly more southerly waters, not because of temperature, but because of the scouring and grinding effect of floe ice on the shores. Although marine algae do occur at some depth and are washed up on the beaches after stroms during the ice-free season, no intensive study of them has been made. The growth and productivity of marine plankton of the Arctic Ocean need study urgently, and such investigations would be well supported by several agencies. Freshwater algae are abundant and occasionally form conspicuous "blooms" in tundra lakes and ponds. Dr. G. W. Prescott and his students have emphasized research on the fresh water algae of arctic Alaska and on the dynamics of their ecology, but most northern areas have received little organized study.

The bryophytes, because they form a rather conspicuous part of the terrestrial vegetation, have received serious attention through field studies in arctic America. Although the basic systematic inventory is reasonably complete, continuing problems of significance lie in the areas of ecology, geographical distribution, cytology, and physiology of bryophytes, as well as their relation to permafrost.

Since earliest times the flowering plants have traditionally received more attention than other groups of plants, and nearly 500 species have been found on the arctic slope of Alaska, alone. The critical studies by Wiggins, Porsild, and Hultén on geographical distribution, and by Löve on chromosome numbers, have produced interesting and useful results. Löve has brought forth much evidence to support the hypothesis proposed by Hagerup, that

Figure 5. A natural rock garden. *Agroseris* is a tiny relative of hawkweed and dandelion.

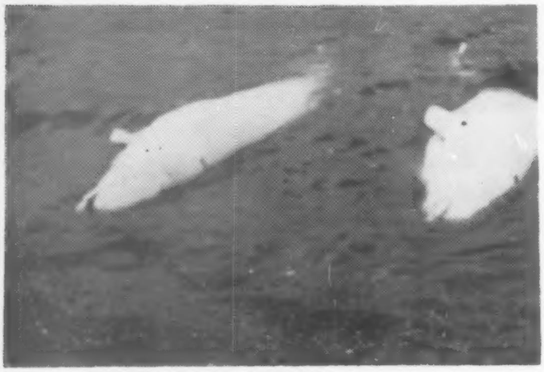


Figure 6. *Beluga,* the so-called white whale, is hunted for food by the Eskimos at Kotzebue.

arctic plants show a greater degree of polyploidy and therefore possess a greater gene pool or genetic resource with which to resist the unfavorable environment. Cytological research on the growth of roots very close to permafrost and of meiosis in flowers subjected to daily temperatures below the freezing point should yield results of great interest.

The higher animals of arctic America are much better known than the higher plants, for purely practical reasons. The primary diet of the Eskimo for many centuries past has consisted of many species of marine animals, with especial emphasis on fish, walrus, and several species of seals and of whales. Occasional catches of polar bears, of caribou, and of birds joined other meat caches for ripening or for freezing, depending on the season of the year. The journals of early arctic exploring expeditions are filled with interesting accounts of the natural history of the higher animals and of the folklore of their use by the Eskimo. Later, professional hunters, trappers, and fishers added much to the folklore of the higher animals. Nevertheless, our knowledge today of the biology of even the larger mammals of arctic America is surprisingly incomplete, in spite of occasional regional studies, as those of Harper, Porsild, and Rausch. Of all vertebrates in arctic America, the birds are probably best known. When one contemplates the vast range of migration of many species of birds, for example the arctic tern which winters in Patagonia, he is reminded of that corner cafe in Paris, of which was said that if one sat there long enough, all his friends would eventually pass by.

The invertebrates of arctic America are still relatively unknown and need intensive and serious study. The insects, one of the largest groups of organisms, have received some attention, but their biology is still full of surprises. One of my ex-students, Dr. Wilfred Schofield, was sent on an official insect survey of Cornwallis Island, to discover that insects were few and that mosquitoes were absent! This situation, fortunate from a humane standpoint, enabled him to divert his attention to the collection of plants. Another anomalous situation was experienced by Dr. Paul Hurd, of the University of California, much to his discomfort. Studying the Collembola of the Point Barrow area, he discovered too late that some of these small insects had been carried through the cotton filter of his aspirator apparatus and had successfully set up housekeeping in his sinuses, a brand new environment from which they were dislodged only by long and painful treatment. Although some regional studies are of great importance (Weber, 1950), a comprehensive treatment of arctic American insects remains far in the future.

The marine invertebrates of the Point Barrow area are of enormous interest. Although the Arctic Ocean remains ice covered for all but one or two months of every year—and occasionally never becomes free from ice—the fauna is surprisingly temperate in its general aspect. The bottom fauna, as ascertained from dredging, does not seem too far different from that found much farther south, under wholly different conditions. One is amazed to see various kinds of starfish, including basket stars and sea urchins; sea anemones; jellyfish; and other marine organisms that would seem to be more at home in northern California than in the Arctic Ocean. A "must" for biologists

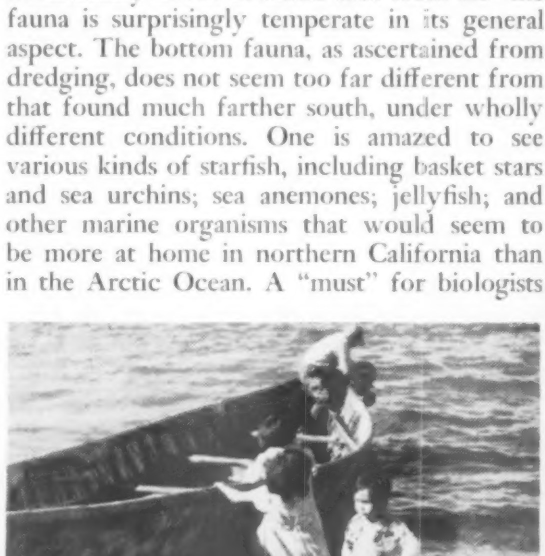


Figure 7. The old and the new—Eskimos use outboard motors on their age-old umiaks or skin boats.

interested in the arctic marine habitat is the report on arctic invertebrates of Point Barrow by MacGinitie (1955).

As implied throughout, the very physical conditions that make the arctic region what it is lead inevitably to ecological problems that need solution. An excellent analysis of the vegetation dynamics in Alaska has been made by Dr. Max Britton, and we await with impatience the publication of the results of his sophisticated and cleverly instrumented studies of microenvironments at Point Barrow. The results of these ecological researches will be extremely useful to workers in every biological field. Extensive studies of the ecology of lemmings, ground squirrels, and of songbirds have been carried out in the Point Barrow region by Frank Pitelka, William Mayer, and others.

For genetic and biosystematic studies in such large and enormously complicated arctic groups as willows and locoweeds, among others, some sort of botanical garden must eventually be established in northern Canada or Alaska—or both. Genetical studies of species related to horticultural varieties will certainly turn up genes for hardiness and resistance as well as other desirable characteristics for use in plant-breeding programs. The genetics of fertility and sterility in arctic plants likewise need study because of the many alternative means of vegetative reproduction that they display.

Although paleobotanical and paleontological work in Alaska began early, this is still a highly promising field because of the abundance of fossils and the existence of forests in previous geological eras where only tundra now occurs. Bones of Pleistocene animals,

Figure 8. *Diapensia lapponica*, a common arctic plant, occurs in the United States outside of Alaska only on Mt. Washington.

Figure 9. At Lake Peters, *Cystopteris fragilis*, the fragile fern, grows well north of the Arctic Circle.

many of them now extinct, are surprisingly abundant. The University of Alaska has accumulated a small mountain of fossil bones found in the soils overlying the auriferous gravels near Fairbanks. Microfossils, especially foraminifera, spores, and pollen grains, have not received the attention in arctic areas that they deserve, except for the private, probably never-to-be published works of oil companies, who use their data for the purpose of correlating geological horizons in exploration for oil, which, incidentally, is surprisingly abundant in arctic Alaska. The use of Carbon-14 techniques and other modern dating methods in the arctic will give data extremely helpful for understanding the dimension of time during which the present types of vegetation have developed, as well as the cyclic changes in past climates.

At the moment, the most experimental and highly instrumented kinds of investigation of the behavior of plants and animals under arctic conditions may have to be carried out in the well-equipped laboratories of more temperate regions. However, where natural conditions cannot be duplicated or even imitated, such experiments will eventually have to be made in the arctic, as laboratory facilities become available.

The Arctic Research Laboratory at Point Barrow, the northernmost part of the United States, offers many opportunities for research in arctic Alaska, in any appropriate field of science. Operating through the University of Alaska, the Geography Branch of the Office of Naval Research has for several years provided funds for the support of the Arctic Research Laboratory. Scientists who have research funds available to them from the Office

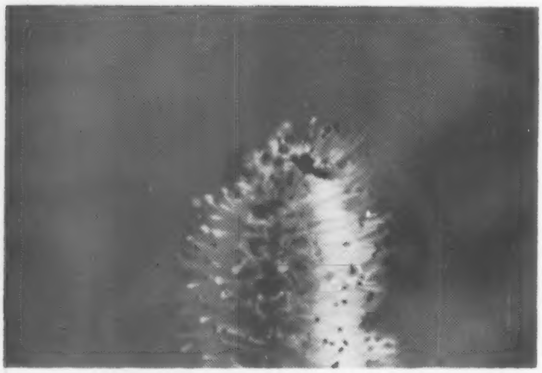


Figure 10. Diptera on staminate catkin of willow, which is probably insect pollinated.

of Naval Research, the National Science Foundation, the Arctic Institute of North America, or from other responsible agencies, and whose research falls within the scope of interest and activity of the Arctic Research Laboratory, may apply to ONR for the privilege of working there. If space and other facilities permit his residence at the Laboratory, the scientist is provided with full logistic support, which means that he is furnished with food, lodging, heavy clothing, and placed in the field where his plans require or else given laboratory space and equipment for his work in one of the 17 laboratories. Any qualified scientist who is seriously interested in taking advantage of the many facilities of the Arctic Research Laboratory in order to implement original investigations on arctic problems, and who has developed well thought out research plans, would be well advised to discuss them informally with Dr. Max Britton of the Geography Branch of the Office of Naval Research before making a final application. At the moment, some facilities are available, and much scientific work is going on near Cape Thompson, between Kotzebue and Point Hope. Here the Atomic Energy Commission has established a base for extensive environmental studies before some proposed underground experimental explosions of atomic materials are detonated, in a year or two. Dr. John Wolfe, of AEC, is in charge of these environmental studies. Other facilities for biological research in arctic Alaska may occasionally be found in the various Distant Early Warning or DEW Line sites along the arctic coast of Alaska and Canada, as well as in other quasi-military establishments. With a research grant adequate for chartering the service of a bush plane, a properly equipped investigator can reach nearly any area of arctic Alaska in which he wishes to work, quite independently of the agencies or bases just mentioned. However, in my opinion, one is well advised to work through the Arctic Research Laboratory or the Arctic Institute of North America, or both, because of the facilities and logistic services that these organizations can give, as well as their experience in cutting red tape.

In Canada, the Defense Research Northern Laboratory at Churchill, on the west coast of Hudson Bay, offers excellent facilities to investigators with research problems appropriate to the geographical locale, at the tension zone between the forest and the tundra. Although the latitude is only subarctic, the depressed isotherms of the midcontinent produce an arctic climate which in turn controls the limit of trees. Occasional highly qualified workers have been accommodated in weather stations and other establishments on the various islands of the Canadian Arctic Archipelago, even as far north as Alert, on Ellesmere Island, at a latitude of 82°. Again, with adequate funds for transportation, sufficient equipment, and the highly essential approval of the proper authorities, a serious worker can place himself in that geographical spot whose conditions are most appropriate to the requirements of his work.

It may be appropriate to note here that the University of Copenhagen's Biological Laboratory on Disko Island, on the west coast of Greenland, is probably the oldest arctic scientific station in existence. Admission to the Laboratory and permission to work anywhere in Greenland are given by a central commission

Figure 11. The most successful and the most numerous animal in Arctic America is the mosquito.

on arctic research at the University of Copenhagen. Moreover, workers must be able to qualify for a Danish visa and for official permission to visit Greenland. Occasional researchers with special needs have received permission to center their investigations at U.S. installations, at Sondrestromfjord, at Thule, and at other bases in Greenland.

I am obliged to add somewhat parenthetically that the Russians have far more arctic scientific research and experimental bases and stations than America does, scattered through the vast reaches of the Siberian arctic and the arctic islands north of the Eurasian continent. Whether scientists from outside the Iron Curtain are welcome or even tolerated in these laboratories, I do not know. My only advice to anyone who is resourceful enough to arrange an invitation to work in one of the arctic research stations in the USSR is that he insist on a round-trip ticket.

Fortunately for the biologist interested in the literature on arctic research, he can find the primary publications cited or reviewed in a relatively few sources. Among the most important publications covering arctic research are Meddelelser om Gronland (Copenhagen), Arctic (Montreal), Bulletins of the National Museum of Canada (Ottawa), Proceedings of the Alaskan Science Conferences, Polar Record (Cambridge, England), and Arctic Bibliography (Washington, D. C.).

In summary, then, in arctic regions every field of biology—and every science—presents innumerable problems that demand investigation. We must not overlook those important

Figure 12. Lake Peters Research Station, at an altitude of twenty-eight hundred feet, in the eastern part of the Brooks Range, Alaska. This Station is administered by the Arctic Research Laboratory at Point Barrow.

areas lying near the periphery of biology, as sociology, ethnology, anthropology, and archaeology. The Eskimo is one of the most adaptable of all of mankind, and we must have a scientific record of his culture, his language, and his traditions before they disappear completely. An excellent publication on the human ecology of Alaska Eskimos by Robert and Marietta Spencer has recently appeared. These problems are challenging and timely and many are now of real importance to our national welfare. Moreover, because of the novel environmental conditions, and the relatively small amount of previous work, investigations of arctic problems are very apt to be unusually rewarding and productive.

General References

Anderson, J. P. 1959. Flora of Alaska and adjacent parts of Canada; an illustrated descriptive text of all vascular plants known to occur within the region covered. Iowa State University Press, Ames.

Arctic Bibliography. Prepared for and in cooperation with the Department of Defense under the direction of the Arctic Institute of North America. Vols. 1-9. 1953-1960.

Benninghoff, W. S., Jr. 1952. Interaction of vegetation and soil frost phenomena. Arctic 5: 34-44.

Bliss, L. C., 1958. Seed germination in arctic and alpine species. Arctic II: 180-188.

Böcher, T. W., K. Holmen & K. Jakobsen. 1957. Gronlands flora. Kobenhavn.

Britton, M. E. 1957. Vegetation of the arctic tundra. pp. 26-61, 18th Biology Colloquium, Oregon State College.

Drew, J. V., J. C. F. Tedrow, R. E. Shanks & J. J. Koranda. 1958. Rate and depth of thaw in arctic soils Trans. Amer. Geophysical Union 39(4): 697-701.

Harper, Francis. 1956. The mammals of Keewatin. Univ. Kansas Museum Nat. History. Misc. Publ. 12:1-94.

Hopkins, D. M. 1959. Some characteristics of the climate in forest and tundra regions in Alaska. Arctic 12: 214-220.

——— & R. S. Sigafoos. 1951. Frost action and vegetation patterns on Seward Peninsula, Alaska. U. S. Geological Survey Bull. 974 (C): 51-101.

Hultén, E. 1941-1950. Flora of Alaska and Yukon. Parts I-X. Lunds Univ. Arskrift, N. F. Avd. 2, Vol. 37-46.

Löve, A. 1959. Origin of the arctic flora. *In* Problems of the Pleistocene and Arctic. McGill Univ. Museums Publ. 1: 83-95.

——— & Doris Löve. 1957. Arctic polyploidy. Proc. Genetics Soc. Canada 2: 23-27.

MacGinitie, George E. 1955. Distribution and ecology of the marine invertebrates of Point Barrow, Alaska. Smithsonian Misc. Coll. 128(9): iv, 201 pp.

Péwé, T. 1957. Permafrost and its effect on life in the North. pp. 12-25, 18th Biology Colloquium, Oregon State College.

Polunin, N., W. R. Taylor, R. Ross, C. D. Kelly, W. C. Steere, R. Singer & E. Dahl. 1954. The cryptogamic flora of the Arctic. I-VII. Bot. Review 20: 361-476.

Porsild, A. E. 1945. Mammals of the Mackenzie delta. Canadian Field-Naturalist 59(1): 4-22.

——— 1951. Plant life in the Arctic. Canad. Geog. Jour. 42: 120-145.

——— 1957. Illustrated flora of the Canadian Arctic Archipelago. Nat. Mus. Canada Bull. 146: 1-209.

Raup, H. M. 1954. Some botanical problems of the Arctic and Subarctic Regions. Arctic 7: 229-235.

Rausch, Robert. 1951. Notes on the Nunamiut Eskimo and mammals of the Anaktuvuk Pass region, Brooks Range, Alaska. Arctic 4(3): 146-195.

Spetzman, L. A. 1959. Vegetation of the Arctic Slope of Alaska. *In* Exploration of Naval Petroleum Reserve #4 and adjacent areas, northern Alaska, 1944-1953. Part 2, pp. I-III, 19-58. U. S. G. S., Washington, D. C.

Steere, W. C. 1952 Botanical research in Alaska. Selected Papers of Alaskan Science Conference, pp. 103-110. Arctic Inst. North Amer.

———. 1953. On the geographical distribution or arctic bryophytes. *In*. I. L. Wiggins, (Editor), Current Biological Research in the Alaskan Arctic. Stanford Univ. Publ., Biol. Sci. II: 30-47.

Weber, Neal A. 1950. A survey of the insects and related arthropods of arctic Alaska. Trans. Amer. Entom. Soc. 76: 147-206.

Wiggins, I. L. 1951. The distribution of vascular plants on polygonal ground near Point Barrow, Alaska. Dudley Herb. Contrib. 4:41-52.

———, I. L. 1957. Potentialities for the future development of the American Arctic. pp. 131-134, 18th Biology Colloquium, Oregon State College.

——— & J. H. Thomas. 1961. Flora of the Alaskan Arctic Slope, Univ. Toronto Press. (In press)

Ninth Paul B. Mann Congress

Jointly sponsored by the New York Association of Teachers of Biological Sciences and the Thomas Alva Edison Foundation, the 9th Paul B. Mann Biology Congress will be held at the American Museum of Natural History, New York, Saturday, May 13, 1961. The meeting will be reports and demonstrations of biological research by students in New York high schools. Students, teachers, and parents are cordially invited to attend. Each participant in the Congress will receive a Paul B. Mann Memorial Science Key. Standards to be used for selection of participants are accuracy, honesty, thoroughness, originality, reference readings, and presentation. For additional information, contact Mr. Sanford S. Blair, High School of Performing Arts, 120 West 46th Street, New York 36.

Fallout

Children now five and six years old will get the greatest doses of radioactive strontium-90 and cesium-137 already in the air from nuclear weapons tests, claims Dr. Wright H. Langham of the Los Alamos Scientific Laboratory. This is because they will be in their period of greatest growth—and consequently greatest uptake of bone and muscle-building materials —during the time of greatest fallout. The biochemist calculated that the world average strontium-90 bone and bone marrow doses for today's children, as a result of bomb tests to date, would be ten per cent as high as those received from natural background radiation. The cesium-137 bone and bone marrow doses, he added, would be five per cent of natural background.

Field Trips

JOHN M. YOUNGPETER, *Lakota Schools, Burgoon, Ohio*

This article will attempt to avoid re-hashing all of the values gained from actual tripping. The greatest need for trips is unquestionably to get more students into the field to do real observing, rather than learning nature from the textbook. Presently, because of many television programs and new books in the subject, we have entered a new era of increased study of nature and its ways. Taking full advantage of this, the biology teacher may "capitalize" on the surge of interest, go beyond the movie-text level, getting students out in the field where they can see nature in action. To see one frog in a pond is worth many movies of such. To have caught insects, classified them, and noted the special adjustments suiting them for their surroundings, is more than equivalent to many written pages on these topics. And to have collected algae and invertebrates in ponds and puddles, and successfully cultured them in class, fully rounds out student appreciation for living nature. Too much of our biology, the science of living organisms, is drawn from dead examples or text-book pages!

The following material offers suggestions to aid the interested instructors to meet many of the problems forced by our school-day schedules and school locations.

No place to take your class or club on a field trip? Unbelievable! On the campus area surrounding most schools, it is rare to be unable to find a host of representatives of insect orders, birds, various soil organisms, such as molds, round worms, earthworms, as well as the trees, and other plant representatives. Look everywhere—under leaves, in cracks in bark, in the soil, in the air, etc. Going beyond the campus, weedy lots in the school area, usually serve admirably by housing a host of biological specimens. Here, especially, for example, seed dispersal can be studied. Some schools are fortunate enough to be located in rural surroundings which lend themselves well to such work.

Finally, let us consider the problem of teachers who work in a situation where no campus or other area is readily available. In this case, the resourceful teacher may, as an alternative, structure part of his classroom into a "field." This approach lends itself especially well to fresh water aquatics but may be modified to other ecological situations as well.

In-the-Classroom Trips

Admitting the artificiality of such a type of work, it still serves to provide the general student with experience in observing living, active organisms. In two situations the in-the-classroom field trips are of special value. They are: in classrooms of schools which, because of their location, have no campus grounds, and in all classrooms where the duress of winter weather makes field trips impractical.

In an urban situation, the teacher and the biology club, or volunteer members of classes, must go to the city parks or outlying areas to collect. Tanks, aquaria, tubs, jars, culture dishes, etc., serve admirably as artificial ponds in the classroom. The collected material, in its natural water, should be so distributed that too many creatures are not placed in one container. Although this type of work lends itself especially to aquatic biology, terraria, too, may be stocked with animals and plants from the local areas or ecological areas to be studied. It is of definite value to keep records so that the source and nature of each collection are available.

Of even greater and perhaps more lasting value is the use of this approach to overcome the difficulties of winter weather. Students seem to forget that living creatures are "still alive" during the winter. This winter collecting is most easily done through holes in the ice. It should be kept in mind, however, that the ice be thick enough to safely support the weight of the group. To make holes in the ice, the use of an ax or spud is most desirable. Students many times are more efficient, able, and willing for this job than the instructor.

The equipment necessary for such a collecting expedition, besides warm clothes, includes: tubs, pans, buckets, jars, a rake, an ax or spud, a screen of some type, and dissecting equipment.

After a hole of sufficient size, to permit the bucket to pass through, has been opened, dip some water into the containers. Then with the rake or other hook, scrape bottom to collect the debris, plants, etc. Spread this material out on the screen or ice and sort out the desired specimens. It is also beneficial to place some mass of debris in the containers unsorted. The mud and other material in the mass will yield a great wealth of invertebrates, tadpoles, perhaps even turtles, frogs, salamanders, etc. When the pond has been well-explored, and material has been carefully net-checked, take the material to the laboratory or classroom. This material then should be well distributed in jars, tanks, etc.

With a surprisingly great number of live specimens for use, the procedure of keying, adaptations to environment, and life histories may be well-studied. A very interesting project which may be prepared by either committees or the class as a whole may be entitled, "Winter Life in ________ Pond." It may include diagrams, activities, life history, food habits, of the studied animals. This proves to be an excellent ecology project. Mimeographed guide sheets can benefit the students while observing the method of locomotion, food getting, size, etc.

A summary, then, after the organisms have been evaluated and classified to their ecological niches is necessary. Too many times after good field trips a general summary and conclusions are not drawn. The result of such an approach leaves the students with, what perhaps to him, are many unrelated and unimportant facts. The summary must tie together and crystallize the important conclusions which may be drawn from such work. This is as necessary if using the in- the-classroom "trip" as the outdoor type.

Club Trips

A greater amount of freedom exists with planning of trips for biology and other science clubs. Time and place are much less restrictive than any classroom work. If field work is planned, and one of the essential reasons for such clubs is to acquaint the student with more of nature and its ways, the leader or instructor must be familiar with the area and what biological phenomena may be found there. The trips should not, however, be limited to field work entirely. Trips to every resource of the community which may utilize science are worth consideration. Careers, too, of course, may be influenced on such ventures. Do not overlook trips to:

Hospital laboratories
Medical technician laboratories
Funeral home tours
Food processing laboratories
Farms (chicken, chinchilla, etc.)
State fish hatchery
State game farm
Science departments in local universities and colleges
Scientific supply companies
Greenhouses
Research laboratories
Museums and zoos. Contact people in charge prior to the trip to get a "behind the scenes" tour.
City water systems
City sewage disposal plants

In arranging such trips, whenever possible, it is recommended that the leader or instructor should go over such details as the age-levels of the students, the science backgrounds of the students size of the group, etc., so that the host may know what level to have displays, explanation materials, etc.

As in planning any group event, the better the planning, the better will be the final outcome. Details such as transportation, conduct, lunch arrangements, etc., must be re-evaluated for each event. Beyond this, a preview program of what is to come on that trip, whether collecting or tour-type, is fine. For collecting trips, special time should be devoted to the ecological area, biotic representatives which can be expected, and those which *may* be found, and the values and use of the equipment, such as nets, screens, jars, pans, preservatives, lenses, keys, and other reference material, as well as proper dress, which will be needed and used. For introduction to a tour to a laboratory, industry, etc., the value of that job to society, and its biologic implications and career requirements, should be reviewed. As a reminder, also, the instructor should remind the students that their full attention should be given to their host. Beyond this a thank you note telling what points of the trip were most interesting is a great value to class and industry.

To enhance the value of either collecting trips or tours, groups should be instructed to take notes. Emphasis on the failure of most memories and the importance of written records cannot be stressed too much. The value of taking field and observation notes will be lasting for those particularly who plan scientific careers. This technique especially teaches careful observation.

As any instructor knows, no student will be more interested than the one who has seen and collected animals and plants he studies. The "personality" of each plant and animal develops as it is seen in its natural surroundings. Beyond this, to enrich the background of any student with greater appreciation for requirements of careers involving science, may have such value as to change the life of the student. The instructor himself will not only get the pleasure of collecting trips and tours but may get the joy of knowing his efforts were a definite aid in the career selection of his students.

Endeavour Prizes

Prizes totalling 100 guineas are offered by Imperial Chemical Industries Limited, publishers of the quarterly scientific review *Endeavour*, for essays submitted on scientific subjects. In addition to the cash prizes, the prizewinners will receive invitations to attend the whole of the British Association meeting at Norwich, from August 30 to September 6, 1961. All expenses will be paid, including travelling expenses within the United Kingdom.

As the primary purposes of these awards are to stimulate younger scientists to take an interest in the work of the British Association and to raise the literary standard of scientific writing, the competition is restricted to those whose twenty-fifth birthday falls on or after June 1, 1961. Five prizes will be awarded. The subjects for the essays are as follows: 1. The Periodic Table: its modern significance; 2. Meteorology and its possibilities; 3. Radioastronomy; 4. Waste: its utilization and disposal; 5. The mammalian egg; 6. Computers and their uses; 7. The form and structure of leaves; 8. Photoperiodism.

The essays, which must be in English and typewritten, should not exceed 4000 words in length, and only one entry is permitted from each competitor. All entries should be addressed to: The Deputy Secretary, British Association for the Advancement of Science, 18 Adam Street, Adelphi, London, W.C.2. The envelope should be clearly marked "ENDEAVOUR PRIZE ESSAY."

Mark

An interesting monthly wall newspaper is available from the CIBA Pharmaceutical Products, Inc., Summit, New Jersey, by writing the Editor, Mr. Gaylord J. Hoftiezer. It is an excellent summary of current science, and will make a very fine bulletin board edition on a monthly basis.

Film Catalog Supplement

The Circulation Department, Audio-Visual Center, Indiana University, Bloomington, Indiana has just published its 1961 *Supplement* to its *1960 Catalog of Educational Films.* It may be obtained from the above address.

Water Pollution Conference

DePaul University, Chicago, Illinois, will hold a two-day conference May 15-16, 1961 on water pollution in the Great Lakes area.

"The Curious Naturalist"

A new monthly four-page paper, September through June, is being published for students in grades 8-12 by the Massachusetts Audubon Society, South Lincoln, Massachusetts. The cost is $1.50 per year.

Cholesterol Relative

Cholesterol-alpha-oxide, a chemical relative of cholesterol, a substance sometimes linked with hardening of the arteries, can cause cancer in test mice and rats. This is the first time that this material has been shown to produce cancer in animals without the aid of another substance, reported Dr. Fritz Bischoff of Santa Barbara Cottage Hospital Research Institute, Santa Barbara, California. Previously it had been shown that the compound could cause cancer in mice when injected under the skin along with an oil.

Why Follow the Leader?

LEONARD G. SCHEEL, *Crystal Lake Community High School, Crystal Lake, Illinois*

How many college students, preparing for biology teaching, have found themselves in a field course with twenty-five others, trailing behind a fleet-footed professor as he poured out generic and specific names of plants and animals until one name sounded like the one before? How many of these same students have tried in vain to reach the front of the line in an attempt to hear what the instructor had to say about a tiny, seemingly insignificant flower? Many students, surely, have stumbled over the briar, sunk into the leaf mold, and trampled a Jack-in-the-Pulpit in just such an effort only to find, after dropping pad and pencil, that the instructor had advanced thirty feet ahead and was once more giving a scientific name that sounded something like *Symplocarpus foetidus*,[1] and with this the student was about ready to give up the whole odoriferous experience.

One would think that after experiencing frustrating situations such as these, the modern biology teacher would renounce the "follow the leader" approach to the field in favor of coming down to earth and giving the student some genuine self-discovery experiences in field biology.

This writer realizes that approaches to field biology are as many and varied as there are biology teachers. The following approach was developed through student-teacher planning and has proved to be most effective and highly potential as a high school biology teaching unit.

The class is first oriented in the basic field procedures. These might include the use and care of equipment, methods in making accurate observations, and proper attitude in field laboratories.

The class is then divided into four teams consisting of six or seven persons each. These teams are identified as:

1. the environment team
2. the plant team
3. the invertebrate team
4. the vertebrate team

[1]Skunk Cabbage.

Each team is given specific responsibilities while in the field. A suggested outline follows.

I. The Environment Team

The environment team's duties are to accurately measure and record the many environmental factors that influence the biota of a given area. A few of these factors are listed here:

A. Temperature

Usually two members of the environment team will be designated as temperature recorders. They will be responsible for determining the various temperature readings to be taken. In a terrestrial environment this would include the temperature of the air and soil at various heights and depths. In an aquatic environment the water and substratum temperatures are included.

Recordings of temperatures at different locations will vary with the type of environment and the physical conditions present at any given time. North and south exposures should be considered as different environments as well as areas in or around a body of water.

B. Wind Direction and Velocity

These environmental factors constantly vary from one moment to the next. In order to accurately measure the wind velocity expensive equipment is usually necessary. High school students can develop apparatus which is usually efficient. This may consist of four paper cups attached to two crossed bars pivoted in the center. The circumference of the circle circumscribed by the cups is known and with several simple mathematical formulae the velocity may be calculated. A compass may be used to determine the direction of the wind.

C. Humidity

Humidity should be measured at several locations in a given area, particularly in an aquatic habitat. This may be easily accomplished with the use of a sling psychrometer available from scientific supply houses.

D. Acidity or Alkalinity of the Soil and Water

The use of pH Hydrion paper is probably the most economical method of determining this factor. It is advisable that the individual responsible for taking the pH have with him a vial of distilled water and a watch glass. This will facilitate the pH reading of the soil.

E. Soil Profile

The soil profile is valuable in determining the type of parent soil material, the amount of erosion that his occurred, and the mineral content of the soil. If equipment is not available, it can be easily improvised by using a one-inch auger bit welded to a piece of iron pipe with a T handle.

F. Light Intensity

The light factor plays an important role in determining the biota. A practical method employed in obtaining relative light factors is the use of a camera light meter.

II. Plant Team

In orienting the plant team some teachers prefer familiarizing students with the use of taxonomic keys, while others are content with allowing the students to apply descriptive names to the different species. In either event they should be well aware of the types of plant succession and be able to spot signs of this natural phenomenon. Mapping of an area is often valuable to show the effects of seed dispersal on the plant population.

The soil profile is valuable in determining the type of soil material, the amount of erosion that has occurred, and the mineral content of the soil.

III. Invertebrate Team

The vast number of invertebrate species found in any given area is an indication that this team has a heavy responsibility. Again they should have a method of categorizing these animals. They should also have various means of trapping invertebrates. A few of the many methods are listed here:

A. Samples of soil, log decay, and leaf material may be taken and set in Berlese funnels.[2]

B. The shaking of a shrub or small tree into a plastic table cloth is effective.

C. A coffee can may be submerged below the ground filling in the soil to the rim. A piece of meat is placed in the can. The can is then camouflaged with leaf mold. After a day or two this usually proves effective in the capture of certain dung and scarab beetles.

D. The effective use of insect nets and water dip nets will yield a wide variety of invertebrates.

IV. Vertebrate Team

The individuals working with the vertebrate team should, again, be well prepared to identify the various vertebrates they may encounter. This identification may be made by the presence of the animal itself or through the identification of a nest, hole, den, pellets, or feces, tracks, gnawing, signs of predator-prey relationship or any other signs.

The team may wish to attempt the capture of live specimens with the aid of live traps. In an aquatic environment the use of a seine proves valuable. Fish, frogs, even turtles and snakes are gathered in this way.

After the work in the field is completed, the four teams return to the class room where they should immediately make arrangements for the collected specimens. Small invertebrates, such as insects, may be kept alive for some time in bottles. A large aquarium may be used for aquatic species and a terrarium for certain terrestrial forms. A vasculum is valuable for leaves and certain herbaceous plants. Specimens may also be preserved in alcohol or formalin following the usual procedure.

[2] "How to Collect and Preserve Insects," H. H. Ross. Illinois Natural History Survey, Urbana, Illinois. Bul. 39.

Students learn the effective use of air nets in the field. They will usually yield a wide variety of insects in any environment.

The day after the field trip the teams are allowed to assemble in small groups in the classroom to identify their specimens and organize their data.

The real value from a unit such as this comes when the members of a class can discuss their findings and discover for themselves the interrelationships that exist between organisms and their environment. Here are several situations that may arise in a field experience and the type of class discussion that may evolve.

1. Several earthworms are found at the depth of 12 inches on a south-facing slope, while earthworms are found at six inches on a slope facing north. A discussion about light, temperature and soil factors and their influence on these animals may arise.

2. A dense moss growth is found in a heavily shaded forest area. This may be followed by a discussion of the effects of humidity and light on bryophytes. It may also involve the mineral content and pH of the soil.

3. The plant team may find the lengths of petioles or flower stems to be longer in a shaded area than in a sunlit area. The effect of light on plant growth hormones (auxins) should be discussed.

4. Deformed trees or shrubs or small communities of a particular species of plant with wind-borne seeds should show the effects of wind velocity and direction.

Taxonomic keys may be used to identify the plant species of an area.

These examples are but a few of the many discussion points that may arise.

A general glance at the history of teaching methods of biology will clearly reveal an evolution from the presentation of a very factual course to the present day conceptual methods. This writer can recall the tedious trips to the field following the instructor and frantically scribbling scientific names of trees and other flowering plants with rarely a mention of the niche they occupy in the whole of nature or of the dynamic influence they have on other organisms in their environment. This archaic field method is still practiced in high school and college biology courses today. The student with a knack for rote memory will probably derive a measurable knowledge of the taxonomy of local species, but will he gain an understanding of the principles of ecology? If the objective of any given field study is primarily taxonomic, then the "follow the leader" approach may prove most effective. If, however, the objectives are more basic, as they are in most general biology courses, and an attempt is made to develop broad ecological concepts, to discover the interrelationships that exist between organisms and their environment, and to develop an appreciation for nature as a whole, then the "follow the leader" approach too often becomes ineffective and a waste of time. To develop an effective field program, the teacher must incorporate as many of the interacting factors as are feasible. In this way a student will evolve in his thinking conceptually, and he will be richly rewarded with a basic understanding of nature.

Don't forget the AIBS meetings at Purdue University, August 27-31, 1961.

A High School Class in Ecology

W. W. SHOUGH
Dover High School, Dover, Ohio

During the second semester of the 1959-1960 school year at my school, a discussion of the ways to enrich our science program led to the organization of an advanced class in biology. Since our already crowded schedule of studies would hardly permit the addition of another course, it was decided that the advanced biology had best become a part of our summer program. Our summer program is very flexible, so that we are not pressed for time. It was possible to devote a half day to a biology class. With this much time available, we could spend much of it in field work.

As the plan developed beyond the tentative stages, we saw it as a high school course in ecology and field biology. We would spend three days a week in the field and two in the laboratory, studying the plant and animal communities in our region, making collections of the unknowns, using our lab periods for discussions, comparisons and identification. Fortunately, Dover is at the center of the Muskingum Conservancy District. Within a half hour's drive we have lakes, ponds, streams and swamps. We have abandoned farms, strip mines, native and cultured woodlots. Almost all stages of ecological succession, excepting a climax forest, were readily available. Our schedule of field trips was set up to include at least two examples of each type of community so as to provide material for comparisons as well as contrasts.

Students who had received a grade of "B" or better were invited to participate in the program. Prior commitments such as family vacation, summer employment, etc., eliminated many candidates, but 14 students "survived" to enter the course. In addition to the class work, each student chose an individual research problem suited to his talents and interests.

The advanced biology class was a great experience for both teacher and pupils. For six weeks, we worked three hours each morning in field and laboratory. Many afternoons were spent on individual problems, in planning specific portions of the class work, and in preliminary visits to habitats. The students earned a semester of credit in adavnced biology. We collected, identified, and recorded the plants, animals, and physical characteristics of each of the typical communities of our area in Ohio. We learned the use of keys, we found how birds act at 4:30 a.m., and what the woods is like in the middle of the night. We discovered that a swamp is an interesting and worthwhile place, and that a strip mine is not so horrible after all. We learned the difference between an opinion and a fact, and found out that we still have a lot to learn about biology.

The results of the individual research problems were read and discussed during the last meeting of the class. Each paper was rated on a scale of values developed by a committee from the class.

Abstracts of the six papers which received the highest rating are listed here.

Edna Bay, senior, made a study of precipitation and its effect on the growth of pine. Using the distance between each group of branches on the tree, she measured 100 pine trees for the years 1951, 1952, and 1953. She included both red and white pine, and, of course, discovered that other factors, in addition to precipitation, affected the growth of her trees. Her report included tables, graphs, and a growth formula. She found that mild winters, followed by a wet spring, had considerable effect upon increasing the growth of our pine.

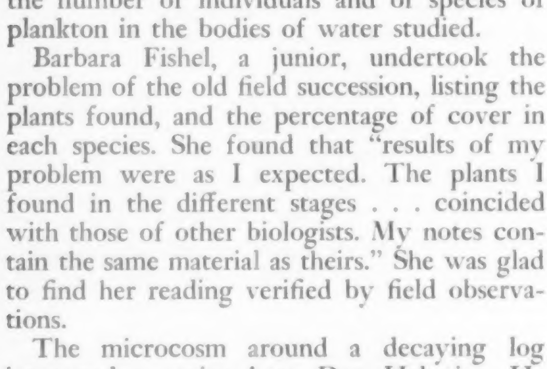
Tom Bear, a junior, studied the food habits of frogs as shown by stomach analysis. Tom collected twenty green frogs, washed out the stomachs, identified, and tabulated the contents. He found "the amount of grass, leaves, pebbles, and other foreign objects to be very high. This was probably caused by the frog making a pass at a food item and missing it. Since his eating is nothing but a reflex, he has no choice as to whether he wants to swallow it or not." Beetles and crayfish ranked highest in both frequency and volume of diet so far as actual food items were concerned.

After considerable practice in techniques of collecting and in identification of the forms

studied, Marilyn Dusenberry, one of our seniors, made a study of the animal plankton in certain ponds and streams near Dover. For her final report, she made a series of collections during one twelve-hour period, hoping thus to avoid variations due to weather conditions. She found that rate of flow, level of pollution, and light intensity affected both the number of individuals and of species of plankton in the bodies of water studied.

Barbara Fishel, a junior, undertook the problem of the old field succession, listing the plants found, and the percentage of cover in each species. She found that "results of my problem were as I expected. The plants I found in the different stages . . . coincided with those of other biologists. My notes contain the same material as theirs." She was glad to find her reading verified by field observations.

The microcosm around a decaying log interested a senior boy, Dan Helvoigt. He divided his dead trees into four stages according to the degree of decay. He found "much more evidence of animals than the animals themselves." He noted that a tree "by merely being dead opens a space in the canopy, allowing a smaller tree more light . . . or sun-loving plants space to spring up." He concluded that animals bring about changes in a dead tree and that these changes themselves cause other changes in the animal population surrounding the log.



One of the senior girls, Kathy Ream, wrote and excellent account of her observations of a swamp. She visited her area at various times to study the effect of weather, sunlight, and temperature on the animals present. Her diary of visits, her photographs, and her drawings made her paper an excellent account. Her technique included transects, quadrat studies, and direct observations from an elevation near the swamp. Her diary of weather conditions and the behavior of the swamp animals showed a real love of nature and was ranked high by the class.

In conclusion, we should like to thank the administrators of the Dover Schools for the opportunity to conduct our summer biology program, and certainly we are grateful to to several private land-owners who permitted us to use certain areas for study.

Position for Teaching Assistant in Conservation Education

A graduate teaching assistantship in conservation education will be available starting Septembr 1, 1961, in the Department of Forestry and Conservation, Purdue University.

The position is a two year program of study and teaching leading toward a master's degree in conservation. Teachers or graduate students with undergraduate training in one of the resource specialties such as agronomy, forestry, wildlife management, or general biology, ecology, or agriculture are eligible to apply.

The assistantship pays $1800 for the 10 months academic school year plus the advantage of exemption from University fees and tuition except for $39.50 a semester.

All interested inquiries should be addressed to: Professor Howard H. Michaud, Department of Forestry and Conservation, Purdue University, Lafayette, Indiana.

Cancer

The American Cancer Society has spent about $85,000,000 on cancer research since 1946.

Ecology Studies in High School Biology

DANIEL LEE DINDAL, *Worthington High School, Worthington, Ohio*

Background

From observations it has been noticed that many high school students complete biology courses without becoming aware of the interrelationship of plants and animals to the soil, climate, and weather. Various chemical relationships to living organisms have not been taught or realized by biology students. With this in mind a five week field study of ecology was required of 130 sophomore biology students at Worthington High School. Worthington High School is situated on an eighty acre tract of land and thus provided an excellent setting for this project. However, the size of the school area need not be a limitation to this type of project. This project with slight modifications could be set up in any area sanctioned by the school or community such as metropolitan parks, vacant fields, stream areas, wooded, or grassy areas.

This project took place during the last six weeks of the year. A total of approximately seven hours of class time was devoted to this outdoor project by each student each week. Many were observed spending additional time after school or on week ends. Usually if class time was well spent this extra work was unnecessary. However, many advanced students in biology would spend many additional hours.

Problem

Each student was faced with the following problem: to carry out a complete ecological study of a 15′ x 60′ plot of land which included three different ecological communities. A final report of findings was required.

The purpose of this experience was threefold. First, the study was meant to provide an application of much of the information learned and studied throughout the school year. Next, the experience of this type provided a visualization of the interrelationships of physiology, life histories and ranges, flora and fauna, climatic, geologic and chemical phenomena. And last, this was thought to be a practical way of teaching conservation in a biology course.

Materials

1. Measuring tapes
2. Stakes
3. Thermometer
4. Geologic and topographic maps.
5. Glass jars
6. Soil testing kits
7. Cloth bags
8. Shovels
9. pH indicator paper
10. Ping pong balls
11. Plant presses
12. Axe and saw
13. Microscopes and slides
14. Snap and live mammal traps and bait
15. Bird banding traps
16. Dissecting equipment
17. Reference books

Many times all of the above equipment was needed in the field at once. A permanent supply center was maintained in the teacher's automobile trunk. In this way the teacher could circulate and sign out any material at any plot. Before leaving the plot to go back to the school all materials were checked back into the "supply trunk." Very few items were lost.

Procedure

Preliminary planning

A number of preliminary plans were made prior to the study. A six page dittoed explanation and instruction pamphlet was prepared for each student. All of the field guides from the school library were taken for a five week period so that all students would have equal access to them. These were carried to the field in the automobile supply trunk. Some field guides and reference books at two community libraries were reserved so that all students had similar opportunities of utilizing them. Arrangements were made with the physical education teachers to have the students change into field clothes in the locker room. Alternate plans for related classroom laboratory experiences were made for rainy weather. Interrelationships had been stressed

Figure 1. Students computing water holding capacity of soil sample.

throughout the year prior to this plot study. The plots were selected and were staked out. The study was organized so that there would be special emphasis on a different aspect of ecology each week.

Student Organization of Plot

The first week of the study was devoted to familarization with the plot. The students "staked" their assigned claims and started to measure them exactly. They were then to draw a map to the scale of $\frac{1}{4}'' = 1'$ on which they were to record the ecological communities, trees, clumps of plants, rocks, and all features of relief. Each plot was made up of three communities, a temporary stream community, a pioneer weed community, and a forest community.

Students then had to show some preparation of some organized note taking technique. Each student also started to keep weather data during the first week. Some placed thermometers at various points on their plot, others relied on home thermometers or local newspaper, radio or television, weather reports.

Soil and Water

The second week was devoted to details of soil, water, and geology of the area. Experiments from a Soil Conservation Service pamphlet were modified and utilized.

This particular week was the only rainy one during the five week period so soil samples were brought into the classroom where most of the following tests were carried out. It might be well to set aside this week's work for rainy days because classroom facilities were very useful.

1. Bedrock
   a. Rocks from outcrops near the plot area were collected and identified.
   b. The entire geologic picture was observed from a geologic map of Ohio.
2. Soil
   a. Soil particle size
      1) Samples were taken from various areas in the plot.
      2) Soil sample was poured into jar filled with water.
      3) The mixture was left to settle.
      4) Each particle layer was measured and approximate percentage of clay, silt, and sand was computed.
   b. Soil texture—Percentages of different soil particles were located on the triangular Textural Classification Chart published by the U.S. Department of Agriculture. This was a very simple device for students to use to find soil texture.
   c. Soil testing—Different areas within the plots were compared.
      1) A junior chemistry student prepared a reagent for the pH color test.
      2) Percents of potassium, phosphorus, and nitrogen were checked with a garden soil testing kit.
   d. Water holding capacity—Comparisons were made of the subsoil and samples of topsoil from various areas of each plot.
      1) A cloth bag was filled with a dry soil sample that had been weighed.

Figure 2. Obtaining soil samples.

2) The soil was soaked with water.
3) The bag of soil was allowed to drain, was weighed and the dry and wet weight differences were calculated.
4) Comparisons were then made.

e. Soil fauna
1) The numbers of animal species in one cubic foot of topsoil and one cubic foot of subsoil were compared.
2) Topsoils from the different ecological communities were compared.

f. Erosion—Areas of erosion were to be located, classified as to sheet, rill or gully erosion, and indicated on the maps.

3. Water—The temporary stream in wet weather was swift moving, but was made up of only stagnant pools during dry periods.
a. Daily pH readings were taken with pH indicator paper. The pH changes were compared and reasons for the changes were investigated.
b. The drainage of the plot was observed and recorded. Details of the topography were observed from topographic maps.
c. The speed of the stream was compared daily by recording the time it took a ping pong ball to flow a given distance.
d. Investigations were made concerning stream pollution. Sewage and drainage systems which empty into the overall area were studied.

Figure 3. Students studying plot map.

Figure 4. Estimating height of trees on plot.

Flora

The third week was devoted to the study of plants and forestry.

1. All plants on the plot were to be identified.
2. Students, if they wished, could supplement their final report with pressed, labelled leaves and plants from their plots. Most of them did this.
3. The clumps and areas of plants were to be located and drawn to scale on their maps. These areas were color coded.
4. Dates were recorded as to when plants emerged from the soil, flowers bloomed, length of blooming, seed formation, and dates when leaves appeared on trees.
5. Forestry
   a. Measurements of height and diameter (DBH) were made. These were recorded in chart form.
   b. The economic values of each species were to be found and recorded in the report.

Fauna

Animals were studied during the fourth week.

1. A check list of birds was kept over the whole period and bird nests were located, identified, and observed.
2. Bird banding traps were set on various plots. Birds captured were banded with Federal bands and released.
3. Many water and soil microorganisms were observed and classified.

4. Invertebrates were collected, kept alive or preserved, and studied. Microscope slides of various invertebrates were prepared. This provided some practice in microtechnique.
5. Each student conducted a small mammal survey. Snap traps and live traps were used. Mammals were identified, stomach content studies were made, and study skins were prepared.

Reporting

The fifth week was used to complete any unfinished work and to finish the written report.

1. All data were finalized in chart and graph forms, and the map was completed.
2. All organisms observed were classified according to the phyla, classes, and orders that were studied earlier in the year. Common and scientific names were also included.
3. Original illustrations of particular plants, animals or structures were added to the final reports of many of the students.
4. A bibliography of all books used was a requirement.
5. The final and most important part of the report was the students' conclusions. Here all of the information obtained earlier was to be compared and relations and interrelations were to be shown. Most students did a fine job writing this part. Some of them wrote conclusions that would be acceptable in many college classes.

Results

The results, reports, and reactions of the students to the project were very pleasing. The threefold purpose was fulfilled.

Since each student had his own plot he could work at his own speed. This is one of the reasons why a group was not assigned to a single plot. Also, if a student failed to get his work finished because of foolishness he had only himself to blame.

This type of study is going to be an annual project. Particular plot areas will be changed, and new ecological methods will be employed including some water chemistry. This was an extremely satisfactory experience for both student and teacher!

References

1. Benton, A. H., Werner, W. E., Jr., *Workbook for Field Biology and Ecology*, Burgess Publishing Co., Minneapolis, Minn. 1957.
2. Burt, W. H., *Mammals of the Great Lakes Region*, The University of Michigan Press, Ann Arbor, 1957.
3. Conant, I. H., *Field Guide to Reptiles and Amphibians*, Houghton-Mifflin Co., Boston, 1958.
4. Conrad, H. S., *How to Know the Mosses*, W. C. Brown Co., Dubuque, Iowa, 1944.
5. Cuthbert, M. J., *How to Know the Fall Flowers*, W. C. Brown Co., Dubuque, Iowa, 1948.
6. Cuthbert, M. J., *How to Know the Spring Flowers*, W. C. Brown Co., Dubuque, Iowa, 1949.
7. Jahn, T. L., *How to Know the Protozoa*, W. C. Brown Co., Dubuque, Iowa, 1949.
8. Lyon, T. L., *The Nature and Properties of Soils*, Macmillan Co., New York, 1952.
9. Peterson, R. T., *Field Guide to the Birds*, Houghton-Mifflin Co., Boston, 1947.
10. Petrides, G. A., *Field Guide to Trees and Shrubs*, Houghton-Mifflin Co., Boston, 1958.
11. Pohl, *How to Know the Grasses*, W. C. Brown Co., Dubuque, Iowa, 1953.
12. Soil: *The Yearbook of Agriculture*, 1957, U.S. Government Printing Office, Washington, D.C.
13. *Teaching Soil and Water Conservation*, 1957, Soil Conservation Service, U.S. Department of Agriculture, Washington, D.C.

Hallucinations

Visible evidence of the way a rare Mexican mushroom induces hallucinations is being recorded for the first time in abnormal webs woven by drugged spiders. The webs, which have wide-spaced threads and incomplete spirals, suggest that spiders, like people, feel fatter and bigger than usual under the influence of psilocybin, said Dr. Peter N. Witt of the Upstate Medical Center, Syracuse, N. Y. Psilocybin is a synthetic drug developed to duplicate the effects of the *Psilocybe mesicana*, which has been used for centuries in primitive religious ceremonies.

Epileptics

A simple chemical compound, known to chemists for years, has helped prevent induced epileptic seizures in laboratory animals. The chemical, called hydroxylamine, produces this anti-convulsant effect and also raises the level of a body chemical called GABA (gamma-aminobutyric acid) in the animals' brains, reported Dr. Eugene Roberts of the City of Hope Medical Center, Duarte, California.

Field Biology in the High School Program

HAROLD G. LIEBHERR, *Nicolet High School, Milwaukee, Wisconsin*

How many times have you emphasized to your classes that biology is the science of living things and then proceeded to teach the course using dead specimens? How often have you taught the processes of biological cycles and then failed to take your classes into any natural environment where these cycles could be seen in operation? Have you ever wished to have a class of only the interested students? We feel you can realize these educational and personal goals by teaching a summer course in biology.

When we decided to offer biology during the summer session, it was felt that the course to be offered should not be the same as that offered during the regular school year. Since our school possesses its own four acre nature area, and Milwaukee County is dotted with fine public parks, it was decided that our summer course would be one in field biology. The course was open only to students who had finished the regularly offered course of the 10th grade, and a limit of 15 students was set. The background in biology was necessary because we could then draw upon past learning; the small number was suggested so that the class would be easier to work with in the field.

Field Biology implies that it was a course taught primarily in the field. The school laboratory was used only when necessary to identify specimens, test soil or water samples, or prepare equipment for use in the field.

The first week was used to brush up on techniques learned during the past year, such as classification of plants and animals. Various "keys"[1] were used and the students were required to classify trees, flowers, insects and other specimens using these "keys." In order to study a community it is necessary to know the organisms that make up that community, and one of the best ways to find the names of the organisms is through the use of keys. This first week included a field trip to a county park that contains an arboretum which gave us a fine opportunity to identify specimens unknown to the students.

The next few weeks were spent studying types of communities. The communities chosen represented various stages in the succession of organisms as it occurs in Wisconsin. We started with an old field community, an old dump that had been left alone for a few years and had reverted to grasses and composites. Other communities studied were a shrub stage, a silver maple woods, an oak-hickory woods, and a beech woods. All of these areas were found in nearby county parks and could be reached by a 15-minute drive from the school.

To survey a community it was necessary to divide the class into teams, each team being responsible for the gathering of particular data. One team was responsible for identification of trees and determining their approximate number; another collected soil samples and tested them for pH and soil moisture; a third surveyed the vegetation of the forest floor; while a fourth was responsible for determining the animal life present. After each field trip, time was taken in the laboratory to assemble this data and share it with all

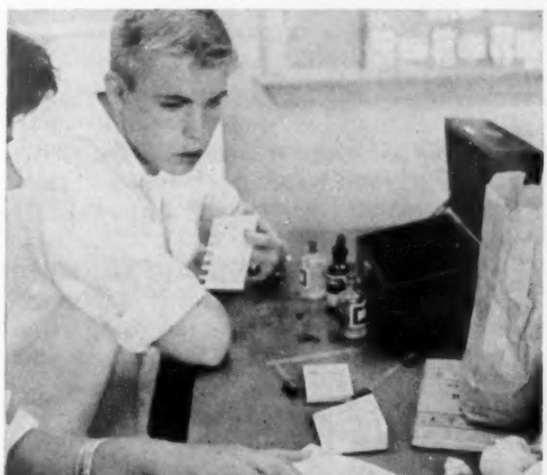


Figure 1. Soil samples were tested for mineral content.

[1]The "How to Know" keys, published by W. C. Brown Co., Dubuque, Iowa, proved very helpful.

Figure 2. Streams and ponds were sampled as parts of the community.

members of the class. This stage of our work concluded with the members of the class writing a paper comparing various stages of this succession picture. Our objective was to lead them to draw generalizations concerning the changes brought about by succession.

An interesting activity centered around a survey of the Milwaukee river. This river borders the school campus and is typical of many of the rivers and streams of our country; it is polluted. This survey was carried out as the other surveys, with the class again being divided into teams. To learn about the river we collected plankton samples, plants and animals from the river bottom, water samples, fish by seining, and made a record of the vegetation bordering the river. In the laboratory we identified the specimens and tested the water for its oxygen and carbon-dioxide content. The "Taxonomic Keys to the Common Animals of the North Central States," Eddy and Hodson, proved extremely helpful with this study. Using our collected data, we attempted to construct food chains and other relationships as they occurred in the river. To the students this lifeless appearing stream suddenly took on new significance. It was indeed a community teeming with life.

Other activities involved field trips to several areas of interest within the state, a night spent baiting and collecting moths, and preparing museum skins of birds and mammals. One of the field trips was to a state park where a section of native prairie still exists, and types of plant succession can be seen. Another trip was to the Horicon Marsh Wildlife Refuge in central Wisconsin where we had a tour of the area with one of the Fish and Wildlife Service biologists. Here we were shown how some of our class learning was being put to practical application.

Each student was required to make a scientific collection, to be collected, mounted, and identified in the approved manner. They could have chosen many different organisms to collect, but most of them decided to collect either insects or herbarium specimens. The school supplied them with the mounting materials for their collections, and therefore we kept any specimens we desired.

If you are thinking of placing a course in Field Biology into your curriculum be sure to allow enough time each day so that field trips can be taken. At least two hours daily is needed. Be sure to check on local game laws before taking fish or other animals for scientific collections. In our seining of the river we kept only the rough fish and returned all others to the stream. The birds that were used for museum specimens were house sparrows and starlings; these can be taken without fear of violating any local, national, or international laws.

The course was offered for credit (½ credit for 60 hours work). I feel that the

Figure 3. One team was responsible for determining the animal life of the community.

Figure 4. Starlings were prepared as museum specimens.

student gained knowledge which could not be measured or evaluated by credits. Some of the objectives we accomplished are as follows: (1) the student was able to recognize by sight, plants and animals common to the area, (2) the student was able to recognize various plant and animal communities, (3) they were able to understand plant and animal interrelationships, (4) they were able to identify unknown specimens, and (5) they were able to make a scientific collection. The course gave me the opportunity to cover in much greater detail, material that could be offered only in a superficial manner during the regular school year. When the course had been completed, I had a feeling of accomplishment and now am looking forward to this coming summer and another course in Field Biology. Why don't you offer such a course, too?

References

Benton, Allen H. and William E. Werner, Jr., *Workbook for Field Biology and Ecology*, Burgess Publishing Co., Minneapolis, Minn., 1957.

Eddy, Samuel, and A. C. Hodson, *Taxonomic Keys to the Common Animals of the North Central States,* Burgess Publishing Co., Minneapolis, Minn., 1955.

Jacques, H. E., *How to Know the Insects,* Wm. C. Brown Co., Dubuque, Iowa, 1947.

———, *How to Know the Trees,* Wm. C. Brown Co., Dubuque, Iowa, 1946.

College Botany Conference

The Third Summer Botany Conference at the University of North Carolina, supported by the National Science Foundation, will be held July 31 through August 18, 1961. Like the previous Botany Conferences, the 1961 Conference is designed for teachers of general botany and general biology in liberal arts colleges, teachers colleges and junior colleges from all parts of the country. Recent developments in plant physiology and cytology will be discussed in six one-week lecture series by leading botanists. The principal lecturers will be Dr. C. Ritchie Bell of the University of North Carolina, Dr. Lindsay S. Olive of Columbia University, Dr. Aubrey W. Naylor of Duke University, Dr. N. E. Tolbert of Michigan State University, and Dr. John M. Clark, Jr, of the University of Illinois In addition, evening lecturers will be given on recent developments in other areas of botany by Dr. John M. Couch and Dr. Max H. Hommersand of the University of North Carolina and Dr. W. C. Gregory of the North Carolina State College. Two field trips to areas of taxonomic and ecological interest will be conducted by Dr. A. E. Radford of the University of North Carolina.

Stipends of $200 each plus a travel allowance will be awarded to 30 applicants by the selection committee. Application blanks and a brochure describing the Conference may be obtained from the Director of the Conference, Dr. Victor A. Greulach, Box 1268, Chapel Hill, N. C. Completed applications must be received not later than May 10, 1961, to be assured of consideration.

Leukemia

The American Cancer Society has currently allocated more than $1,500,000 in a broad program of research related to leukemia. Until a cure is found for this incurable disease of the blood-forming tissues, leukemia will take the lives of some 13,000 persons in the United States each year. A fifth of them will be children under the age of 15.

Mt. Lemmon Revisited

LORENZO LISONBEE
Phoenix Union High Schools and Phoenix College District, Phoenix, Arizona

"Mt. Lemmon—A Case History of a Field Trip" appeared in the October, 1957 issue of the *American Biology Teacher* and reported the first annual ecology tour to the Tucson area and nearby Mt. Lemmon by the biology department of Phoenix Camelback High School.

Forty students made that first trek. Its success encouraged a second one a year later with 80 students participating. It then became an annual activity, each year adding approximately one bus to the caravan.

This past October 280 students participated, transported by seven chartered busses. Teachers and administrators at Camelback High now consider it one of the most important educational experiences of the year, and it seems to have become one of the school's traditions.

The trek is usually made the second weekend in October, after spending at least two weeks covering a unit on inter-relationships of organisms and environment, botanical history of Arizona, Merriam's work, wherein he developed the life zone concept which, incidentally, was done in Arizona in and around Flagstaff and the nearby San Francisco Peaks. Life zone maps of Arizona are prepared, and reference is made to Brandt's life zone study in his *Bird Life of Arizona.*

We believe this activity has more significance today than ever, for one of the most important concepts, and probably the most difficult, in today's biology is that concerning the influence of environment on cells, tissues, organs, organisms, biotic communities, and Planet Earth, in its spatial environment. And, of course, woven through this whole topic is the study of form, function, and adaptation.

It seems to be a difficult topic for most students at the start. It might be one of those things, that because it is so obvious, it is difficult. But the students slowly catch hold, and after a few days, interest picks up, and before the unit is over, the majority seems to be fascinated by it all. The idea that their own bodies is a biotic world with many cell communities, each of which is subjected to its own environmental conditions, is an intriguing one. The idea that man, like other organisms, is subject to environmental influences and is not exempt from the same forces of nature that have influenced the location of habitat and formation of structure of all plants and animals is also an intriguing one to these youngsters. The significance of this interpretation in the general field of biology has reached the point where many biologists say that all approaches to the study of biology now follow, more or less, ecological pathways.

Three main events are now included in the tour. First, an early morning two-hour visit to the Lower Sonoran Desert Museum near Tucson; second, a brief stop at the University of Arizona campus for a thirty minute lecture from a biologist "in the flesh"; and, third, the drive to Mt. Lemmon from the city of Tucson. Arrangements for each event are carefully planned weeks ahead by correspondence with the personnel involved.

Tucson is approximately 120 miles from Phoenix. On the morning of the tour busses start loading at 5:00 a.m. at the high school campus, and the caravan leaves promptly at 5:30. Very few youngsters are left behind due to a "phone-your-buddy" routine that begins at 4:00 a.m.

At least one adult rides in each bus, and after a few minutes away from the campus instructions for the day are carefully repeated over the bus's sound system, reminding the students of things they have already been told previously in their biology classes. A name sheet is passed among the students. Each checks his name, and the sheet becomes a roster.

The students are instructed to learn the names of the persons sitting immediately around them. The latter is done for the purpose of quickly identifying the youngster who may be missing or who is tardy in getting on the bus. We never have had difficulty with late loaders thus far.

Included among the various things each student takes with him is a road map, a notebook

Studying the exhibits in the water resource section of the museum.

for note taking, guide sheets, and a lunch which is eaten at one of the stops up the Mountain. The guide sheet gives instructions and cues for the educational and informational aspects of the day's activities. It suggests, for example, that the student list the mountains passed, the towns encountered, the field crops seen, and the native desert plants observed. The adult is usually one who can identify the vegetation for the students. We pass by hundreds of acres of cotton, citrus, and alfalfa fields, and it has always amazed the writer how many students do not recognize these common field crops.

Our first stop is the Lower Sonoran Desert Museum, a living museum, consisting of several acres of desert plants and dozens of exhibitions of living animals indigenous to the area. The latter includes insects, reptiles, amphibians, fishes, birds, and mammals. Tunnels lead the visitor underground where burrowing animals, bats, snakes, and roots can be seen in their natural soil and spelunker habitats. The Department of Agriculture has constructed a block-long water resource exhibit, which, in itself, is worth the visit to the museum. The caravan arrives at approximately 8:00 a.m. The museum director is expecting us and graciously gives the group "free run" of the grounds until 10:00 a.m. at which time the museum is opened to the public. Guide sheet instructions keep students busy at constructive and interesting activities during the two hours. The director has always been complimentary to our group, and we credit the good behavior of our students to the guide sheets and to the prior briefing and study of background material.

Assembled in one of the lecture rooms, Life Science Building, University of Arizona, listening to a biologist "in the flesh."

We have always been fortunate in securing the services of botanists from the University of Arizona, Tucson, to arrange for the lecture at the campus and to serve as guide-lecturers during the trip up the Mountain. We meet the botanists at the Life Science Building on the campus. They usher the group to one of the large lecture rooms where the students hear a biologist speak on the research being done at the University and where they also receive instructions for the trip ahead. After the lecture the students board the busses for the drive to Mt. Lemmon.

The desert region of Southern Arizona has a number of mountains which rise out of the desert and from the distance look like overturned saucers on a table top. The Catalina Mountain is one such mountain located beyond the city limits of Tucson and reaching

Entering the tunnel leading to underground views of burrows and caves of desert animals.

In the transition zone. Students are listening, watching and taking notes.

an altitude of 9,150 feet. A surfaced road now extends from Tucson to Mt. Lemmon, the highest point of this "overturned saucer." The drive to the top of the mountain is unique in that in an hour, one may drive from Tucson, a city in the desert, to the top of the mountain, passing through most of the life zones on the way. Hudsonian conditions may be reached by roadway, and a little hiking can take one to an arctic-alpine area. At one lookout point along the way one may stand among ponderosa pine and white oak and see the desert far in the distance to the north and to the south.

Usually four stops are made up the Mountain. The lecture is given over a large portable sound amplifier installed in a panel truck supplied by the University and driven by the botanists. The 290 people in the last tour had no trouble hearing the lecturers and the interesting things they had to say about the plant and animal life in the area of the stops.

The lecturers have been men who have been interested in secondary school science, who have been willing to give a Saturday to this cause, and who have been "cued-in" through discussions with the biology teachers as to the goals and purposes of the tour. Each year they have been right "on target" in clinching concepts and pointing up field examples which illustrate important ideas.

After the last lecture, which is given atop Mt. Lemmon among spruce and quaken aspen, we make a stop at a nearby resort village, Summerhaven, for a 30 minute rest period. It is mid-afternoon and the October chill is refreshing to the desert dwellers. The rustic lodge, fitted architecturally into its surroundings, offers hot drinks, sandwiches, a huge fireplace to warm by, and juke box music for dancing. Is there a pleasanter way to end the formal activities of the day?

We are sure the pleasant associations and satisfying experiences encountered during the day have helped important concepts to find a permanent place in the understandings of our students.

We are homeward bound at 3:30 p.m. arriving, on schedule, at our home campus, at 7:00 p.m.

Here are some additional details: The trip is made on a Saturday. Commercial busses are used. The cost is pro-rated among the students, amounting to approximately $5.50 per student for a 350 mile round trip. Students are required to have school insurance or the equivalent. Success of the activity is attributed to background preparation in the classroom, specific instructions on guide sheets to be followed by the students during the trip, interesting places visited and interesting things done as part of the basic activity, and planning and caring for the many details far in advance of tour day. Parents were on hand to meet the students on their return to the campus.

Entrance to the Arizona-Sonora Desert Museum, a living museum of hundreds of plants and animals indigenous to the Southwest deserts. Our group had "free run" of the grounds from 8:00 a.m. to 10:00 a.m.

Doctors Smoking Less

One out of four doctors in the United States who smoked five years ago has quit, according to Dr. Daniel Horn, Director of Program Evaluation of the American Cancer Society.

A Study of the Fresh Water Stream

ROY F. BURLINGTON and JOHN MARK DEAN
Purdue University, Lafayette, Indiana

A fresh water stream can be an important and useful tool for the science teacher. It may be used to show the effect of the environment on biological populations and/or individual organisms. Basic ecological principles can be pointed out by observing the life of a pool, a riffle, or a rapids community. Polluted areas can be compared with relatively clean areas. The adaptations of an organism to these particular habitats in a stream are readily observable. Major physical and chemical factors can be determined by simple methods and correlated with the biological data.

Most local streams or creeks are suitable for study, if field work is possible. Normally, a variety of habitats is easily accessible to the class. Also, the methods and materials needed for a relatively complete exercise are not expensive or complicated. Many items can be constructed from common household articles, and substitutions for the suggested items may be made at the discretion of the teacher.

Fresh water bottom fauna may be collected in moving water by straining the gravel, mud, or sand through a sieve with fine mesh. A hand screen can be used to obtain animals that live in the riffles or rapids. This latter item can be constructed from a sheet of wire screen attached to handles and then used as a small seine. One person should hold it in the current of the stream while another one stirs the bottom upstream. The dislodged fauna will be washed upon the screen which is then lifted carefully from the water. The contents of the screen or the sieve should be placed in a shallow white enamel pan for observation. This may be done at the site of collection, or preferably, the animals can be placed in collecting jars and observed in the classroom. Rocks, gravel, and submerged logs should be examined for attached animals. Forceps are a handy tool for picking out the organisms. Reference collections may be assembled by preserving the specimens in 70% alcohol or formalin.

The flora of a stream should also be examined. Algae and fungi can be studied by scraping rocks and other bottom material. Attached aquatic plants can also be collected and identified. A small hand lens is a useful aid for field work of this type.

Plankton are also worthy of consideration. A plankton net may be constructed from a nylon stretch sock with the toe cut out to accommodate a vial. A small piece of a hanger sewn into the top of the sock will provide easier handling. Stream water poured into the net will concentrate plankton in the vial. Specimens may be preserved in alcohol, but living material should be brought into the laboratory and observed under the microscope. In a rapidly flowing, cool stream, higher quantities of water are needed to obtain a sufficient number of plankton organisms for observation. A larger population will develop

FIGURE 1. Using a hand screen to obtain bottom fauna.

FIGURE 2. Sorting animals from a sieve.

in a slow moving stream or a pool. The diatoms will probably dominate the plankton sample.

By use of microscope slides, another interesting technique can be used to demonstrate habitat differences. The slides may be placed on the stream bottom allowing water to circulate around them freely. Several weeks later they may be recovered and the attached microfauna observed. This type of study may complement the plankton observations.

The physical characteristics of the stream can be integrated with the biological data. The type of bottom, light penetration, rate of flow, and temperature should be noted. Also, it is possible to obtain a topographic map from the U. S. Geological Survey. On the maps one may locate the area to be studied, show the drainage area, and note the gross physical aspects of the stream (falls, rapids, dams, etc.).

In deep areas, the light penetration can be measured with a modified Secchi Disc made from a large pearl button. It should be attached to a marked line with a weight on the underside for stability. The area to be observed should be shaded. By lowering the disc until it cannot be seen and noting the length of the line used, one can estimate the light pentration.

The rate of flow is an important factor. It can be measured by timing the movement of a float over a distance of 50 or 100 feet. A lemon may be used for this study. It floats well and is quite visible. Using the formula $R = \frac{w \cdot d \cdot a \cdot l}{t}$,[1] the flow can be calculated. The constant is normally 0.8 if the bottom is composed of loose rock or gravel and 0.9 if mud, sand, or bedrock is present.

The pH and dissolved oxygen content of the water should be investigated if possible. The method for dissolved oxygen is described elsewhere.[2] A pH determination with litmus paper will suffice for this study.

The teacher should select contrasting areas in the stream to be studied. Pools and rapids usually show the greatest differences. Physical and chemical determinations should be made first. While sampling the stations, disturbance of the water should be kept at a minimum. This can be done by working from downstream against the current. Then, samples of the fauna and flora can be collected.

An organized record of the data should be kept. It may include a sketch map of the area showing where the collections were made. The data for each station might be listed under the following headings:

1. Animals
   a. location
   b. size and abundance
   c. type
2. Algae and Plankton
   a. location
   b. size and abundance
   c. type
3. Physical Factors
   a. temperature

---

[1]R — rate of flow in cubic feet per second.
w — average width of the channel tested in feet.
d — average depth in feet.
a — constant.
l — length in feet of the channel section tested.
t — average time in seconds required for float to traverse section.

[2]Odum, H. T., Ten Classroom Sessions in Ecology, *The American Biology Teacher*, February, 1960.

FIGURE 3. Collection of organisms from an enamel pan.

   b. bottom type
   c. rate of flow
   d. light pentration
4. Chemical Factors
   a. pH
   b. dissolved oxygen

Comparison of the data from two or more areas should show some significant differences if the stations are selected with care. Graphs may be constructed for emphasis and clarity.

Also, if a pond and a creek are near the school, comparisons of the two areas might make an interesting study.

Class participation is an integral part of this exercise. Groups of students should be assigned to each phase of the investigation. The teacher can act as a coordinator and advisor, emphasizing the major concepts of ecology upon completion of the exercise. This should lead to a rewarding experience for the student and the teacher.

Bibliography

Algae in Water Supplies. 1959. Public Health Service Publication #657. ($1.00).

Needham, J. G. and Paul R. Needham. 1941. *A Guide to the Study of Fresh Water Biology*. Comstock, Ithaca, New York.

Needham, J. G. and J. I. Lloyd. 1937. *The Life of Inland Waters*. Comstock, Ithaca, New York.

Pennak, Robert W. 1953. *Fresh Water Invertebrates of the United States*. Ronald Press, New York.

Odum, E. P. 1959. *Fundamentals of Ecology*. Saunders, Philadelphia.

Reid, G. K. 1961. *Ecology of Inland Waters and Estuaries*. Reinhold, New York.

Smith, G. M. 1950. *Fresh Water Algae of the United States*. McGraw-Hill, New York.

Ward, H. B. and G. C. Whipple. 1959. *Fresh Water Biology*. Wiley and Sons, New York.

Welch, Paul S. 1952. *Limnology*. McGraw-Hill, New York.

Welch, Paul S. 1948. *Limnological Methods*. McGraw-Hill, New York.

ABT Regional Directors

Each member of NABT should know about a new feature of our organization, the Regional Directors. Elected for two-year terms, these Directors have a variety of duties which should make the one in your locality a person for you to know and contact. Here are some of their responsibilities:

1. All efforts to increase membership in NABT within the region is one of the important responsibilities of the Director.
2. Each Director is encouraged to initiate regional or local meetings which may be held in conjunction with other organizations and the NABT. These meetings may be held in cooperation with state teaching organizations, local science teacher groups, or professional biology societies.
3. The Regional Director is empowered to set up committees of NABT members within his region to carry out as many of the duties of his office as he deems necessary. These committee members should have their names transmitted to the President and the Newsletter Editor for recognition. One such committee to be set up as soon as possible will be one to suggest nominees for future Regional Director and membership chairman posts.
4. Many professional biological organizations have local chapters, e.g., American Society of Microbiologists, and many of these local organizations are quite anxious to cooperate with the teachers in the vicinity. The Regional Director should contact these organizations within his region offering the services of NABT in any of the educational work which they contemplate. Working with these organizations is an activity in which NABT wishes to become involved more thoroughly.
5. Each Regional Director should initiate an organization to make suggestions for the following points in conjunction with setting up a national outstanding biology teacher award program.

A. A committee to formulate the criteria for making such an award.

B. Set up methods for nominating candidates for such awards.

When these committees have made their suggestions, they should be transmitted to the President so that the reports of all Regional Directors will be coordinated to present to the AIBS our program for such an award system.

6. An important responsibility of the Regional Directors is to give advice by attendance and letters to the officers of NABT and attend Board of Directors meetings of NABT.

7. Regional Directors should feel free to suggest other appropriate programs within their region or programs for the entire NABT. Directors report directly to the President of NABT.

The present Regional Directors with their term of office are as follows:

REGION I. (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont) Mr. Irving Keene, Weston High School, Weston, Massachusetts (1 year term)

REGION II. (New Jersey, New York, and Pennsylvania) Mr. Glenn Ball, Carthage Central High School, Carthage, New York (2 year term)

REGION III. (Illinois, Indiana, Michigan, Ohio, and Wisconsin) Mr. John Gundlach, Neenah High School, Neenah, Wisconsin (2 year term)

REGION IV. (Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota) Mr. Rex Conyers, University City Public Schools, St. Louis County, Missouri (1 year term)

REGION V. (Delaware, Maryland, District of Columbia, Kentucky, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia) Mr. William Foil, Hanes Senior High School, Winston-Salem, North Carolina (1 year term)

REGIONS VI. and VII. (Arkansas, Alabama, Florida, Georgia, Louisiana, Mississippi, Arizona, New Mexico, Oklahoma, and Texas) Mr. Clyde Reed, University of Tampa, Tampa, Florida (2 year term)

REGION VIII. (Colorado, Idaho, Montana, Nevada, Utah, and Wyoming) Dr. Stanley B. Mulaik, University of Utah, Salt Lake City, Utah (1 year term)

REGION IX. (Alaska, California, Oregon, Washington, Hawaii, and Puerto Rico) Dr. Irene Hollenbeck, Southern Oregon College, Ashland, Oregon (2 year term)

Contact your Regional Director to offer your services in his work and to give him ideas on how NABT may be improved in your region.

AV NEWS

RICHARD FOX, *Richwoods Community High School, Peoria Heights, Illinois*

This column is being revised and will appear in the *ABT* each month. It is our desire to put into this column those things which you as biology teachers and as readers of the *ABT* wish. To do this we solicit your suggestions and comments. Those of you wishing to contribute to this column may do so by writing to the above address.

Crayfish Anatomy (C or B & W—11 min.) shows the internal and external anatomy of the crayfish and explains special techniques for crayfish study and dissection. A freshly anaesthetized crayfish is dissected revealing the beating heart and the abdominal muscles. The path of the blood is traced and the action of the gills and bailers are shown. Various other organs are shown and their function and location pointed out. Indiana University Audio-Visual Department. R.F.

Earthworm Anatomy (C or B & W—11 min.) shows the process of cutting and pinning an anaesthetized earthworm. The various systems of the earthworm are examined as to location and function. Close-ups of various organs are featured in this film. Indiana University Audio-Visual Department. R.F.

Orders of Insects (C—30 min.). Describes the general characteristics of insects and then considers each of the nine most common insect orders. Thorne Films, Inc., Boulder, Colorado. R.F.

Frog Heartbeat (C—7 min.). A short film revealing the heartbeat of a pithed frog using extreme close-up and slow motion photography. Thorne Films, Inc., Boulder, Colorado. R.F.

Chick Embryo Explantation (B & W—8 min.). Describes a simple method of explanting the chick embryo from the egg to an agar growing medium in a petri dish chamber. Thorne Films, Inc., Boulder, Colorado. R.F.

Biological Techniques (Produced in cooperation with the Biological Sciences Curriculum Study.) Three concise films demonstrate in close-up the techniques used in handling Drosophila (3 min.), bacterial cultures (5 min.), and removing a frog pituitary (1 min.). Teachers guide is available with each. The three films may be purchased on one reel ($95), as a set of three reels ($105), or separately ($40, $60, $20, respectively). Rentals are available only through the A-V libraries that have acquired the films. For sale only through BSCS, McKenna Bldg., University of Colorado, Boulder, Colorado. R.F.

Journey into Spring (C–30 min.). A detailed observation of animal, plant and pond life with the coming of spring to the English countryside. Contemporary Films, 267 W. 25th St., New York. R.F.

Between the Tides (C—22 min.). Permits the viewer to share the experiences of the naturalist discovering the silent world of seashore life and the not too quiet habits of the thousands of sea gulls and other birds who seek these shores for breeding purposes. Contemporary Films, 267 W. 25th St., New York. R.F.

Quetico (C–22 min.). This shows the natural wilderness of Quetico, an area in the Thunder Bay district on the boundary of Ontario and Minnesota. This is an area of more than one million acres displaying its natural vegetation and animal life. Contemporary Films, 267 W. 25th St., New York. R.F.

Life of the Molds (C or B & W–21 min.). The beneficial and destructive functions of molds as they affect man are shown in this film. Cinephotomicrography is used to show the various phases in the life cycle of molds. McGraw-Hill Text-Films, 330 West 42nd St., New York 36.

George Vuke
Indiana University

Rhythmic Motions in Growing Plants (C–11 min.). This entire film uses time-lapse cinematography to show the circular motion of plants as they grow, the effect of gravity on their direction of growth, their reaction to light, diurnal changes, and the motion of climbing plants as they seek support. The amount that the action is speeded up varies from 1,000 to 5,000 times. The film opens by showing the sprouting of barley seeds and the waving of the growing plant from side to side which motion, the narrator explains, is called circumnutation or nodding in a circle. The undulating motion of roots is shown as they grow from a willow twig.

The next sequence shows the reaction of plants to light. It pictures the closing of clover leaflets at sunset and their spreading again in the morning. The leaves of the lupine react in a similar way. The film also shows the effect of gravity on a potted bean plant that is placed in a horizontal position.

Movements of climbing plants are next shown. The scenes that follow show the tendrils of the wild cucumber as they lash out like whips in all directions; the plant itself moves very little. The tendril finds a support, twists, acting like a turnbuckle, and draws the plant over to the support.

The film concludes by suggesting to the viewer similar observations, explorations, and experiments which he can perform in this interesting field of plant growth.

This fascinating film can be used in a variety of ways with audiences that range from elementary grades through college. Also, it will open new avenues of exploration for the week-end botanist. The use of time-lapse photography results in a dynamic presentation that is possible only through the film medium. This film will assist in stimulating the viewer to further study and experimentation concerning plant behavior including their tropistic reactions to water, light, gravity, contact, and chemicals. It may also be used to show that plants, as well as animals, move and respond to stimuli, two of the characteristics of all living things. The visuals clearly show the various motions of plants; consequently, some teachers may choose to use the film without narration to assist in developing skills in concept formation. After studying the visuals, the viewers could form hypotheses concerning the behavior of plants, to be further tested by the conducting of controlled experiments. More advanced groups may wish to study the plant motions more critically at slower projection speeds. William Harlow, Syracuse 10, New York.

George Vuke
Indiana University

Horizons of Science Series. There are four films in this series, produced by the Educational Testing Service with the assistance of the National Science Foundation that would be of most interest to biologists. They are produced at the level of the high school biology student, both from a conceptual and a vocabulary standpoint. All are produced so that an appreciation for the subject matter and the way in which scientists work is stressed. Thus they are not made primarily to impart knowledge specifically, but rather to foster scientific attitudes.

Visual Perception (C–19 min.) explores the work of Dr. Hadley Cantril of Princeton in his perception laboratory. The film demonstrates how visual distortions occur because we perceive things in relationship to past experience. Stress is laid upon the fact that man is a rational animal and that he can, through problem-solving, overcome these distortions. Also pointed out is the fact that much of our learning comes about through the utilization of previous experience. An excellent film for an animal behavior unit, particularly as a motivation technique.

The Worlds of Dr. Vishniac (C–20 min.). Through the techniques of Dr. Roman Vishniac, the microbiologist, in photographing protozoa, the student is introduced to a few of the more common one-celled animals. The sequences showing how Dr. Vishniac performs his research are extremely enlightening. There may be a great deal of value in showing the high school biology student what a pure scientist's workroom and office looks like. However, the film clips of protozoa shown in the film, while well-done, do not appear to me to be of the calibre of those in the EBF film on protozoa, also done by Vishniac.

Another drawback to the film is the excessive personification. References are made to the amoeba's solving problems and to the protozoans being "happy" in their culture.

New Lives for Old (C–20 min.). Dr. Margaret Mead, the anthropologist, tells of her life with the Manus of the Admiralty Islands some twenty-five years ago and of the changes in their culture that she learned of on a recent trip. Since World War II intervened between the two trips, these changes were great. Unfortunately, no films were taken during the first trip, and the only film report of what the original tribe was like consists of some footage of the more backward natives of today on an out-of-the-way part of the island. However, the film serves as an excellent and informative device to acquaint the viewer with the type of work that some anthropologists carry on and gives rise to some interesting conjectures concerning the thin dividing line between the sciences and the social studies.

The Flow of Life (C—21 min.). This is a story of the blood, much more understandable than *Hemo the Magnificent*, and, in some ways, much more scientific, notably in the area of personification, although some references to Mother Nature do creep in from time to time. Dr. Benjamin Zweifach of the NYU College of Medicine and his associates give us a fine picture of the work of a team of researchers–physicians, microbiologists, geneticists, radiologists, psychologists, etc.–in learning more about our circulatory system. Fine shots of microscopic physiology and of scientists at work are included, and, from an appreciation point of view, it is an admirable film.

It is to be hoped that there will be more films of this type produced. Biology teachers can teach knowledges to better advantage in the laboratory than they can by showing a film, but films that show us how scientists work and that they are human beings carrying on an exciting, strenuous, and important research cannot be reproduced in the school room.

Thomas G. Aylesworth
Michigan State University

BOOK REVIEWS

STUDENT FINANCIAL AID, MANUAL FOR COLLEGES AND UNIVERSITIES, Homer D. Babbidge, Jr., 56 pp., $1.50, The American College Personnel Association, The American Personnel and Guidance Association, Washington, D. C., 1960.

A manual for scholarship officers in colleges, but one which guidance officials in high schools might profit from reading. The perennial argument about merit vs. need is discussed, and there is an explanation of how need is determined.

P. K.

COMPARATIVE EFFECTS OF RADIATION, Burton, Smith, Magee, 426 pp., $8.50, John Wiley and Sons, Inc., New York, 1960.

One of the tasks confronting the biologist working on various biological effects of radiation is to eventually explain these effects in chemical and physical terms. With this task in mind, a group of biologists, chemists, and physicists met in 1959 at the University of Puerto Rico for the purpose of comparing radiation effects in biological systems with those which occur in nonliving systems. The book being reviewed is the record of the talks given by the participants and of the discussions which followed. The emphasis of the conference was on the initial steps in the action of radiation so most of the discussion is concerned with the effects at a molecular level.

The biologist will find in this volume very interesting reviews of some of the recent developments dealing with effects of radiation in the ionizing, ultraviolet, and near infrared regions of the spectrum. In addition, he will encounter some very useful presentations of the theoretical background of the chemical and physical phenomena involved.

Carlos Miller
Department of Botany
Indiana University

FILM 1, ROCKS AND EROSION, Marian Ray; FILM 2, PLANTS AND DECAY, Marian Ray; FILM 3, SOIL PROFILES AND THEIR FORMATION, E. A. Fitzpatrick and Marian Ray; FILM 4, COMPOSITION OF SOIL, Marian Ray; FILM 5, SOIL AND FARMING, Marian Ray, Surbiton, Surrey, England, 1960.

This series of filmstrips is a group of kodachromes on (1) Rocks and Erosion, (2) Plants and Decay, (3) Soil Profiles and their formation by E. A. Fitzpatrick, Ph.D., and (5) Soil and Farming, published by Marian Ray, 36 Villiers Avenue, Surbiton, Surrey, England, 1960. Each filmstrip is accompanied by a guide with commentary for each frame and a filmstrip index. The collection of color

photographs of soil profiles and diagrams are quite complicated and suitable for advanced students.

Frances P. Gourley
LaPorte High School
LaPorte, Indiana

GUIDE TO THE STUDY OF THE ANATOMY OF THE SHARK, NECTURUS, AND THE CAT, 3rd. Ed., 141 pp., $3.50, John Wiley and Sons, New York, 1960.

The general picture of vertebrate evolution is presented in this book by using the dogfish shark as an example of a primitive vertebrate, *Necturus* as an example of a transitional primitive amphibian from which the land vertebrates developed, and the cat is employed as an example of the highest form of vertebrate. A chapter of the skill of *Amia* and the Codfish is included to aid in the understanding of the phylogeny of the tetrapod skull. The plan presented is that of dissecting completely one animal at a time. The systems of a particular body region (thoracic, etc.) are studied together rather than studying one system individually to completion. Mechanically speaking, the drawing are well labeled, the type is easy to read, the ring binding allows all pages to lie flat, and the convenient small size of the book will not take up too much desk top room. The authors state that "this manual was designed primarily for a course in comparative vertebrate anatomy covering one quarter . . . and is intended to serve as a guide for the student in dissecting the animals described." In the opinion of the reviewer the book serves the purpose for which it was written.

Frank J. Zeller
Department of Zoology
Indiana University

GALAPAGOS, Irenäus Eibl-Eibesfeldt, 192 pp., $3.95, Doubleday and Company, Inc., Garden City, New York, 1961.

This is an excellent popular account of personal experiences with the animals of these strange islands, made famous to all biologists by Darwin. Because the author is an experienced ethologist as well as a keen observer, the behavior of the fish, iguanas, birds, sea lions, and others is far better understood and interpreted than is usual in popular writing. The depletion and extinction of some of the unique species is well appraised, and an evaluation of the steps necessary to preserve those which remain is made.

The book has an index to species and a bibliography. There is no map of the islands, an omission which I feel was ill advised, and a discourtesy to the reader. (See National Geographic, May 1959.)

The translation seems to have been done well and the illustrations are good. The book is recommended for high school and college libraries. It can be read for fun or as an introduction to animal behavior and some aspects of evolution.

Sears Crowell
Department of Zoology
Indiana University

FOREST AND SHADE TREE ENTOMOLOGY, Roger F. Anderson, 428 pp., $8.50, John Wiley & Sons, Inc., New York, 1960.

Divided into two parts, one on fundamental entomology, the other on specific insects which are forest pests, this book is a fine type of reference for the high school library. It has an up-to-date treatment of entomological principles. But most of the book is devoted to a description of insect pests by the type of damage they produce. An appendix lists the insects by their tree hosts. The descriptions are detailed, and illustrations are abundant. Written as a text for college classes, it is usable in the high school. Another one of the finest sections is on insect control and surveys. But the descriptions of the common insect pests are probably of most value to the high school student.

P.K.

GRASSES OF BURMA, CEYLON, INDIA AND PAKISTAN, N. L. Bor, 767 pp., $25.00 Pergamon Press, New York, 1960.

The primary purpose of this book is to provide means of identifying the grasses of the regions concerned, and nearly 700 pages are devoted to the systematic treatment. The book also has a fairly lengthy chapter on the morphology of the grass plant, and other chapters on dispersal of grasses, uses of grasses, obnoxious grasses, and a discussion of taxonomy and phylogeny. The last is of particular interest since an attempt has been made to summarize all the recent advances that are contributing to an understanding of grass sys-

tematics. To the author it seems that while the newer work has done much toward an elucidation of this family, the time is not yet ripe for the elaboration of a new system of classification. It is of interest to note, however, in his treatment he has departed somewhat from the traditional arrangement, although his primary purpose is utilitarian rather than phylogenetic. As the dust jacket states, "no research agronomist, agricultural institute, or botanical institute worker should be without this book."

Charles B. Heiser, Jr.
Department of Botany
Indiana University

HERBICIDES AND THE SOIL, E. K. Woodford and G. R. Sagar, 88 pp., $3.50, Charles C. Thomas, Publisher, Springfield, Illinois, 1961.

A collection of four papers from a symposium organized by the British Weed-Control Council which deal with matters eminently practical for the herbicide industry as well as for the practicing agriculturalist. Their content is well indicated by the titles, but the quality varies greatly:

1. Microbial breakdown of herbicides in soils. Here L. J. Audus deals with evidence of adaptation by microorganisms to the destruction of herbicides administered to soils. The work is perhaps too closely restricted to mixed populations in natural soils where more information might have been obtained from work with pure cultures. The pure culture work included in the paper is not extensive enough to reveal, for example, the spectra of adaptive capacities of common soil organisms.

2. The effect of herbicides on soil microorganisms. W. W. Fletcher presents an exhaustive but not very critical review.

3. Physio-chemical aspects of the availability of herbicides in soils. An instructive, learned and useful discussion by G. S. Hartley of the factors controlling distribution of materials applied to soil surfaces. The discussion has much broader implications than the limits of the symposium. It is unfortunate that the author must have failed to see the proof, for he would certainly have insisted on a distinction between the words adsorption and absorption.

4. The persistence of some important herbicides in the soil. A highly practical discussion by W. van der Zweep of the difficulties involved in specifying limits of persistence of effective quantities of herbicides in various agricultural practices.

Charles W. Hagen, Jr.
Department of Botany
Indiana University

STUDIES IN PALEOBOTANY, Henry N. Andrews, Jr., 487 pp., $11.75, John Wiley and Sons, Inc., New York, 1961.

Formal courses in paleobotany, the study of plant life of the past, are now being offered by many American universities and colleges. As plant fossils are integrally associated with rock strata, the teaching of paleobotany, by necessity, invades two major areas of science, botany and geology. Dr. Andrews has succeeded in writing a textbook that can be used by students in both fields. He has supplied botanical background material for the geologists and has stated some principles of stratigraphy, sedimentation, and paleontology to help the botanists.

The sequence of treatment follows plant evolution from the earliest land plants (Psylophyta) through the ferns (Pteridophyta) and seed-ferns (Pteridospermophyta) to the flowering plants (Anthophyta). The author then discusses the Lycopodophyta and Arthrophyta as branches of the main stream of evolution and follows them with a discussion of the gymnospermic groups, the Cycadales and Bennettitales, and the Coniferophyta and Ginkgophyta. A further chapter is devoted to the Hepatophyta and Bryophyta, groups considered to be outside the main stream of evolution.

Fossil plants of the Arctic and Antarctic, and Paleozoic and Mesozoic floral assemblages, are treated in separate chapters, and another chapter is devoted to the evolution of the seed. Two extremely useful chapters to the student and teacher are the last two, chapters 17 and 18. The former is an introduction to palynology, the study of pollen grains and spores, by Dr. Charles J. Felix, and the last chapter describes techniques employed in paleobotany. This chapter also contains a useful standard list of references.

Dr. Andrews has written an up-to-date

account of paleobotanical knowledge in clear and easily understandable language. The book should become a standard guide for the teaching of paleobotany and a paleobotanical reference book for geologists and biologists in general.

G. K. Guennel
Indiana Geological Survey
Bloomington

HANDBOOK OF MICROBIOLOGY, Morris B. Jacobs and Murice J. Gerstein, 322 pp., $8.50, D. Van Nostrand Company, Inc., Princeton, New Jersey, 1960.

This Handbook provides for teachers and students a convenient source of microbiological data. The first 150 pages are devoted to the characteristics of microorganisms–taxonomic, cellular, cultural, physiological, industrial uses. Condensed classifications of bacteria, rickettsiae, viruses, and fungi are followed by an extensive list of antibiotics. Culture media, reagents, and stains, together with formulas, methods, and techniques, occupy some 60 pages. Tables of temperatures and conversions, serotypes, phenol coefficients, differentiation tests, toxins, and antitoxins, toxoids and vaccines, and preparation of test dilutions are included. One table gives the causative microorganism, host, and mode of transmission of each of some 60 bacterial diseases of man and animals; two others provide more detailed data on a number of viral and rickettsial diseases. The surprising amount of information included in a single book will no doubt lead to its wide use by both professional microbiologists and teachers. Although much of the book is not directly applicable to biology teaching on the high school level, it does provide ready access to many items of information not easily found in most high school libraries.

John Breukelman
State Teachers College
Emporia, Kansas

PRINCIPLES OF GENETICS, Eldon J. Gardner, 366 pp., $7.50, John Wiley and Sons, Inc., New York 16, 1960.

A fine text for elementary genetics classes as well as the reference shelf for the high school biology library. The format and illustrations of the book are quite attractive. The organization of the book is logical in that Mendelian genetics are the first order of business, then some cytological evidence, chromosome variations, followed by physiological genetics, and agricultural and human applications. In other words, there seems to be a historical treatment, or at least, order of presentation. The writing is simple and direct. A text to be examined for the elementary class and one to be recommended as a general reference.

P.K.

DEVELOPING CELL SYSTEMS AND THEIR CONTROL, Dorothea Rudnick, 240 pp., $8.00, The Ronald Press Company, New York, 1960.

This is an extremely interesting volume. It includes the papers presented at the Eighteenth Symposium for the Study of Development and Growth held in 1959 at the University of Wisconsin. All ten of the authors are well known for contributions in special fields of research. Each, of course, writes with considerable technical detail about experimentation in his own area. A very nice feature of the book, however, is that each author gives an introduction which orients the reader who is not a specialist in the subject at hand. In fact, some chapters are so clearly written in this respect that bright students in secondary schools should be able to follow the discussions.

The authors discuss recent advances in the knowledge of differentiation in systems ranging from cell parts to whole cells to whole organisms. The information presented has been obtained in studies with a wide diversity of organisms from both the plant and animal kingdoms. The papers are concerned with development in cellular slime molds, regeneration in hydroids, tissue formation from dissociated cells, gibberellins and growth of flowering plants, hormonal control of growth, the role of nervous mechansims in the regeneration of body parts, the biochemical basis of mitosis, biochemical and staining reactions of cytoplasmic constituents, and protein biosynthesis.

Carlos Miller
Department of Botany
Indiana University

ASPECTS OF THE ORIGIN OF LIFE, M. Florkin, 199 pp., $5.00, Pergamon Press, New York, 1960.

This report of a Soviet-sponsored symposium has several notable features. It succeeded in attracting most of the western scientists who have been outspoken in their speculations on the origin of life. Here are included M. Florkin, H. C. Urey, J. D. Burnal, M. Calvin, L. Pauling, and S. L. Miller among others. This group was matched with an equally capable and notable group of Russians, not least of whom was A. I. Oparin. Together they explore the very earliest stages of life's origin, from the evolution of the earth's crust and atmosphere to the nature of the biochemical reactions which must have characterized the primitive, subcellular organisms. It is important that those disagreements revealed do not split the proponents along national lines. Whether the primeval earth was molten or cool is apparently a subject for free discussion even within Russia.

While much of the material which appears in this volume has been published elsewhere, the Russian work has not been readily available and the contributions of the others would appear in the most diverse journals. It was a well-conceived and well-organized symposium, by its nature necessarily highly speculative, but revealing the traps into which the uniformed guesser may stumble. For example, those who accept without question the recent detection of paraffin-like compounds in meteors as evidence of extraterrestrial life should read Kropotkin's review in this volume of research on the inorganic origin of petroleums.

Charles W. Hagen, Jr.
Department of Botany
Indiana University

THE KYBERNETICS OF NATURAL SYSTEMS, D. and K. Stanley-Jones, 145 pp., $6.50, Pergamon Press Inc., New York, 1960.

This is a most unusual book. Even though the spelling, "kybernetics," is different, there is a very good introduction to the biological implications of this concept of feedback. Norbert Wiener in an introductory note emphasizes the great many questions and problems which this book raises concerning this concept. Even the implications for astronomy and other physical science areas are touched on. But the chapters on the biological illustrations of cybernetics are most interesting. The amazing illustrations shown by involuntary muscles in childbirth, etc., are intriguing. Ocular problems are used in voluntary muscle illustrations. Neural control in many phases is taken up in another chapter. Invertebrate and vertebrate behavior are used to show feedback mechanisms in a variety of situations. The concluding chapter applies cybernetics to human society. Biology teachers will find this an intriguing book. It is important to read in an understanding of human and animal control mechanisms in basic physiology. Recommended for teacher and the advanced student. Full of ideas.

P.K.

SELF ORGANIZING SYSTEMS, Marshall C. Yovits and Scott Cameron, 322 pp., $8.50, Pergamon Press, Inc., New York, 1960.

This is a most stimulating book on the problems and progress which has been made in the field of information processing. The computing machines of the past have been ones using "stored" information. Now it seems that machines can and are being built with learning and self-organizing capacities with nonnumerical information. To the biologist, this report of an interdisciplinary conference contains provocative papers which will open up new fields of biological organization and learning theory research. For example, an embryologist reports on the organizational abilities of embryonic cells. Homeostasis is shown as a fundamental example of feedback. Neurologists report on neural activity. Psychologists in the experimental fields report on their experiments and the learning models they are proposing. The main emphasis is on the many facts uncovered by the biologist relevant to computer design. There is a transcription of the discussion sessions following each paper, and there are many relevant charts and diagrams.

While relatively sophisticated for even the better high school science student, the biology teacher and professional biologist will need this book as a background to understand a tremendous field of cybernetics, biological organization, and feedback theory which is now opening up.

P.K.

CLASSICS IN BIOLOGY, Sir S. Zuckerman, 351 pp., $6.00, Philosophical Library, New York,

A collection of essays by notables in biology. However, this is an unusual book in that the essays and excerpts are arranged and chosen as they fit into the themes of "The Unity of Life," "The Diversity of Life," and "Biology and Health." There is no attempt to pick excerpts from the works of great scientists whose works are landmarks in the history of science. This is not to say they have been ignored, however, as Darwin, Huxley, and others are included. Most of the essays are written by English scientists, some well known, and others less known. But the outstanding feature of the book is that it is readable as a coherent book. The separate essays became chapters of a book. Of course, the lucid language which the English scientists use also makes it a delight to read. Here is displayed science writing at its best. It must be pointed out again, that many of the "chapters" are not the reports of research by a scientist. Nevertheless, this book can be highly recommended for the biology classroom library. Indeed, this is one science book that can be recommended to the English teacher who wants to use scientific literature as literary examples. P.K.

PROGRESS IN BIOPHYSICS AND BIOPHYSICAL CHEMISTRY, Vol. 10, J. A. V. Butler and B. Katz, 440 pp., $15.00, Pergamon Press Inc., New York, 1960.

This volume is not for casual perusal, and it is unlikely to find a place in the high school library. Nevertheless several important reviews are included which could serve the teacher or occasional student whose attention has focused in the appropriate direction. Of the nine contributions, six are for those who digest mathematical symbols as readily as verbal ones. In each case the authors should be commended for the lucid treatments of matters which are difficult to convey to the nonspecialist. Outstanding in this group are the analysis of free energy changes involved in the hydrolysis of the "high energy phosphate bond" by P. George and R. J. Rutman and the discussion by D. R. Wilkie of the relation of thermodynamics and biological heat measurements.

The remaining three papers are more readily assimilated. T. T. Puck reviews the effects of radiation on mammalian cells in culture, and J. D. Robertson examines the ultrastructure of the membranes of nerve fibers. A review by A. Gierer of recent work on tobacco mosaic virus is particularly intelligible, comprehensive, and timely.

Charles Hagen
Department of Botany, Indiana University

EXPERIMENTAL BIOCHEMISTRY, A LABORATORY MANUAL, Gerald Litwack, 313 pp., $5.50, John Wiley & Sons, Inc., New York, 1960.

This book has a series of biochemical experiments with full directions, some illustrations, and questions. It is obvious that a full background of chemistry will be needed to use this book, and this will be important to keep in mind if it is under consideration for the high school. However, it seems quite an appropriate lab guide for the college biochemistry class. Chemically well informed teachers may find it useful for some ideas for the advanced biology class. P.K.

BIOCHEMISTRY OF PLANTS AND ANIMALS, M. Frank Mallette, Paul M. Althouse, and Carl O. Clagett, 522 pp., $8.50, John Wiley & Sons, Inc., New York, 1960.

Originally published as a text in agricultural biochemistry, this book now has a format which makes it of great value to those interested in the fundamental, beginning phases of this subject. The reviewer found this an easy-to-read book on an admittedly difficult subject. The authors are to be congratulated on a style which make this text one that can easily be consulted by the biologist and high school teacher alike. The introduction and appendix make clear the agricultural origins and intentions of the book, but the bulk of the book's chapters reveal its solid, useful nature: Properties of Matter, Carbohydrates, Lipides, Proteins, Enzymes, and Energy Transfers. The remaining major sections are devoted to plant and animal biochemistry. It is interesting to note how many of the cycle diagrams have a date which indicates how dynamic the subject is. This is not a book of experiments, but it should be of value—even in the high school laboratory—for reading, reference, and ideas. P. K.

AN APPROACH TO NATURAL SCIENCE, D. H. Brehaut, B. E. Dawson, J. L. Grimsdell, A. R. Paul, J. E. Skull, 264 pp., $1.19, Methuen & Co. Ltd. Publishers, London, 1960.

This is an English general science text for a two-year course which is presumably aimed at the same grade level as our own junior high school students. It has an interesting fusion of biological and physical science concepts. For instance, the chapter on air begins with a fairly orthodox treatment of the constituents of air and some experiments to demonstrate these. However, soon the chapter launches into the experimental evidence showing the importance of air on seed germination, and soon there is a full-scale description of respiration. There are thoughtful questions at the conclusion of each chapter, and there are experiment directions throughout the book. If you are interested in seeing an English version of general science, this is the book to inspect.

P.K.

THE OCEAN OF AIR, David I. Blumenstock, xii + 457 pp., $6.75, Rutgers University Press, New Brunswick, New Jersey, 1959.

The Ocean of Air attempts to bring together information about the earth's atmosphere; its behavior and movements; man's attempts to observe, predict, and control it; and its influence on the ecology of man. The story is well told. Each chapter is supplied with facts and anecdotes to stimulate the reader's interest, and the notes at the end of the volume document the information given in the text. It is not a textbook of meteorology, nor is it a book on ecology. It is written for the layman about his gaseous environment, and the scientist tends to be impatient when the author stops his story to explain what he means by a flow of current or a mutation. It is, however, a book which holds its readers and should stimulate student interest in meteorology and ecology.

John M. Hamilton
Park College
Parkville, Missouri

ENERGIES OF THE UNIVERSE, Eugene Fritz, 124 pp., $4.75. Philosophical Library, New York, 1960.

A difficult to read book, although written in short sentences and paragraphs, on the energies of the universe and the atom. The author's theories are quite radical and unorthodox. P.K.